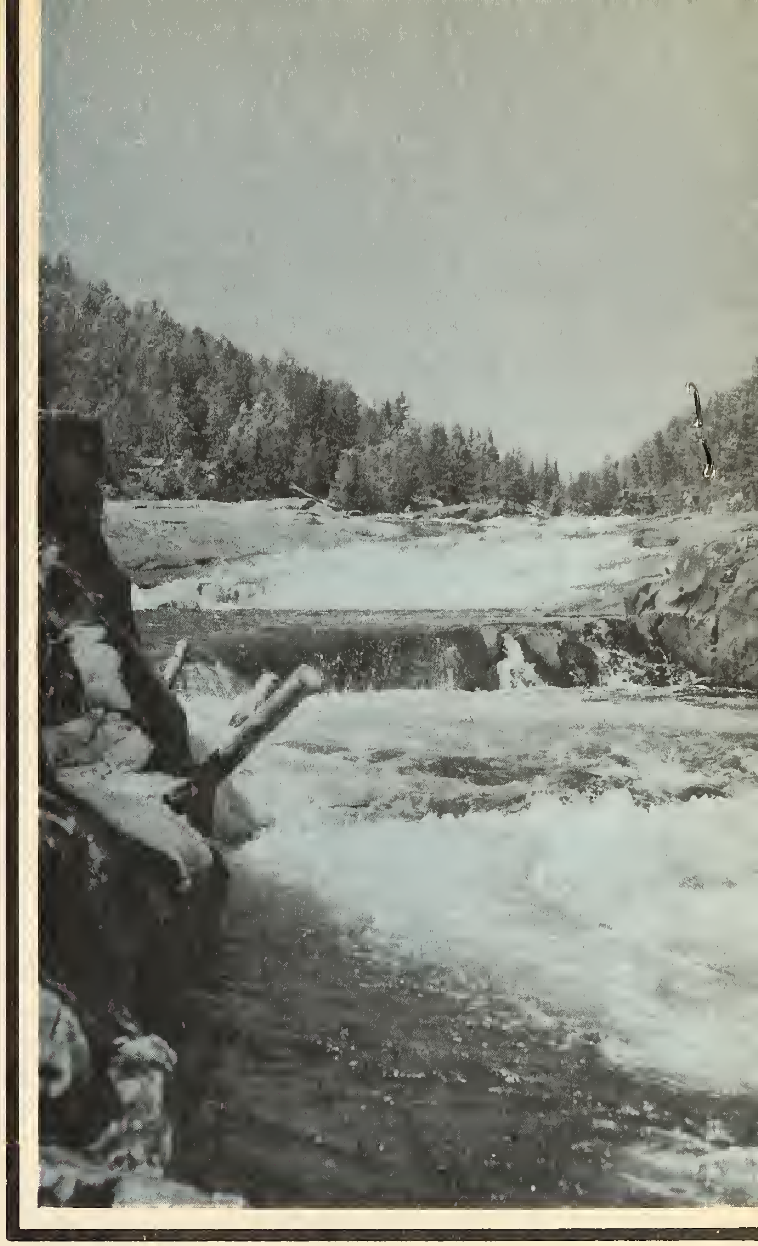
O. W. R. C.

Water Pollution Control Plants



1963 Operating Summary

Ontario Water Resources Commission

ONTARIO WATER RESOURCES COMMISSION

INTER-OFFICE MEMORANDUM

DATE May 15th, 1965

TO Supervisors and District Engineers

FROM J.R. Barr, Assistant Director, Division of Sanitary Engineering

RE:

Attached is a report prepared by the Division of Plant Operations on the operation of Water Pollution Control Plants by this Division. Any observations you may wish to forward to me on the information presented in this report will be relayed to the Director.

J.R. Barr

J.R. Barr

JRB/ec
Encl.

cc: H. Browne,
A.E. Townshend
C.H. Ray
L.B. McIntyre ✓
D.M. Mills
A.E. Redekopp
J.E. Theil

1963 OPERATING SUMMARY

ONTARIO WATER RESOURCES COMMISSION

Water Pollution Control Plants

PREFACE

The Division of Plant Operations has been operating water pollution control plants since June of 1958, when the Stratford plant (project number 57-S-2) was placed in operation. By January 1963 twenty-eight such projects were in operation with others under construction.

Annual reports have been prepared by the Division at the end of each year on staffed projects which have been in operation for the entire year. The content of these reports has evolved to the point where the format used for 1963 will serve as the model for future annual reports. Standardization has facilitated comparison of operating data for the various projects operated by the Division and has prompted the preparation of this report on projects in operation during 1963.

During 1963, six primary treatment plants ranging in size from 0.57 to 8.0 million gallons per day, twenty-one secondary treatment plants from 0.25 to 13.5 million gallons per day in capacity and one total oxidation plant (0.25 million gallons per day) were in operation. Twenty-four of these plants utilized separate sludge digestion facilities and five were equipped with vacuum filter units. This diversity and number of treatment units has permitted a comprehensive analysis and comparison of the various plants.

It is intended that this summary will provide useful information for those reviewing plans of proposed works and serve as an indicator for the selection of compatible treatment units. In addition, as a result of the statistics included, the summary will serve as an aid to the preparation of operating budget estimates and as a guide for gauging individual plant performances.

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PLANTS INCLUDED IN REPORT

	Project		Type	Design Flow (mg)
1.	Belleville	61-S-84	Primary, digestion	3.0
2.	Owen Sound	60-S-68	Primary, digestion	3.0
3.	Point Edward	59-S-36	Primary, digestion	0.57
4.	Port Arthur	58-S-13	Primary, digestion	4.0
5.	Sault Ste. Marie	59-S-20	Primary, vacuum filter	8.0
6.	Trenton	57-S-4	Primary, digestion	1.0
7.	Brampton	58-S-14	Secondary, digestion	2.0
8.	Brantford	58-S-11	Secondary, digestion, vacuum filter	12.5
9.	Burlington D. L.	60-S-51	Secondary, digestion	2.5
10.	Burlington E. G.	58-S-28	Secondary, digestion	0.75
11.	Fergus	58-S-23	Secondary, digestion	0.6
12.	Georgetown	58-S-17	Secondary, digestion	1.5
13.	Huntsville	58-S-15	Secondary, digestion	0.25
14.	Kitchener	58-S-19	Secondary, digestion, vacuum filter	13.5
15.	Lakeview	59-S-43	Secondary, digestion	5.0
16.	Markham Village	59-S-40	Secondary, digestion	
17.	Nepean Twp.	59-S-35	Secondary, digestion	1.5
18.	North Bay	58-S-10	Secondary, digestion	4.0
19.	Orangeville	58-S-16	Secondary, digestion	0.75
20.	Port Colborne E.S.		Secondary, digestion	0.85
21.	Port Colborne W.S.		Secondary, digestion	0.9
22.	Preston	59-S-46	Secondary, vacuum filter	1.8
23.	Richmond Hill	57-S-6	Secondary, digestion	1.6
24.	Stratford	57-S-2	Secondary, digestion	4.0
25.	Streetsville	57-S-5	Secondary, digestion	0.8
26.	Tillsonburg	58-S-12	Secondary, digestion	0.665
27.	Waterloo	58-S-22	Secondary, Vacuum filter	4.0
28.	Westminster Twp.	59-S-33	Total Oxidation	0.25

GRIT REMOVAL

Wide ranges of grit removal were encountered in the review of our grit removal facilities. This wide variation is discussed and accepted as normal in published technical literature.

Quantities of grit will vary, as will the quality, depending upon:

a) types of street surfaces.

b) climatic conditions (frequency of street sanding).

c) types of inlets and catch basins.

d) maintenance of catch basins and streets.

e) amount of storm flow.

f) construction and condition of sewer system.

As shown in Graph No 1 the grit removed at our plants average 2.6 cu. ft. per million gallons of flow. Arbitrarily low and high ranges of 1 cu. ft. per M.G. and 5 cu. ft. per M.G. were set.

Accordingly 10 plants or 37% were considered deficient in grit removal and three plants or 11% were considered to remove higher than normal quantities of grit.

Some reasons for these unusual grit removals are suggested below:

<u>Orangeville</u>

The sewer system is not maintained properly resulting in excessive quantities of grit being flushed down to the plant during storm flows.

<u>North Bay</u>

The grit removal is fairly uniform throughout the year and there is no obvious reason why the grit load is so high. Dumping of manhole cleanings may add to the high grit loads.

Brampton

The grit removal is fairly uniform throughout the year and there is no obvious reason why the grit load is so high.

Belleville

The plant is hydraulically overloaded 97 percent of the time due to storm runoff. This is probably the cause of the low quantities of grit removed although the grit data appears to be incomplete.

Owen Sound

The plant is hydraulically overloaded 48 percent of the time due to storm runoff. Grit accumulations in the digester are proof of the inadequacy of the grit removal facilities.

Preston

Grit is removed in the primary sedimentation tank and is removed on the vacuum filter along with the sludge.

Port Colborne (West Side)

Grit removal data is incomplete.

Nepean

The plant is hydraulically overloaded 82 percent of the time due to ground water infiltration. This is probably the cause of the low quanitities of grit removed.

Richmond Hill

Grit removal data is incomplete.

Lakeview

The low quantities of grit can probably be attributed to the small amount of runoff reaching the plant or inefficient grit removal facilities.

Waterloo

The low quantities of grit can probably be attributed to the small amount of runoff reaching the plant or inefficient grit removal facilities.

Markham Village

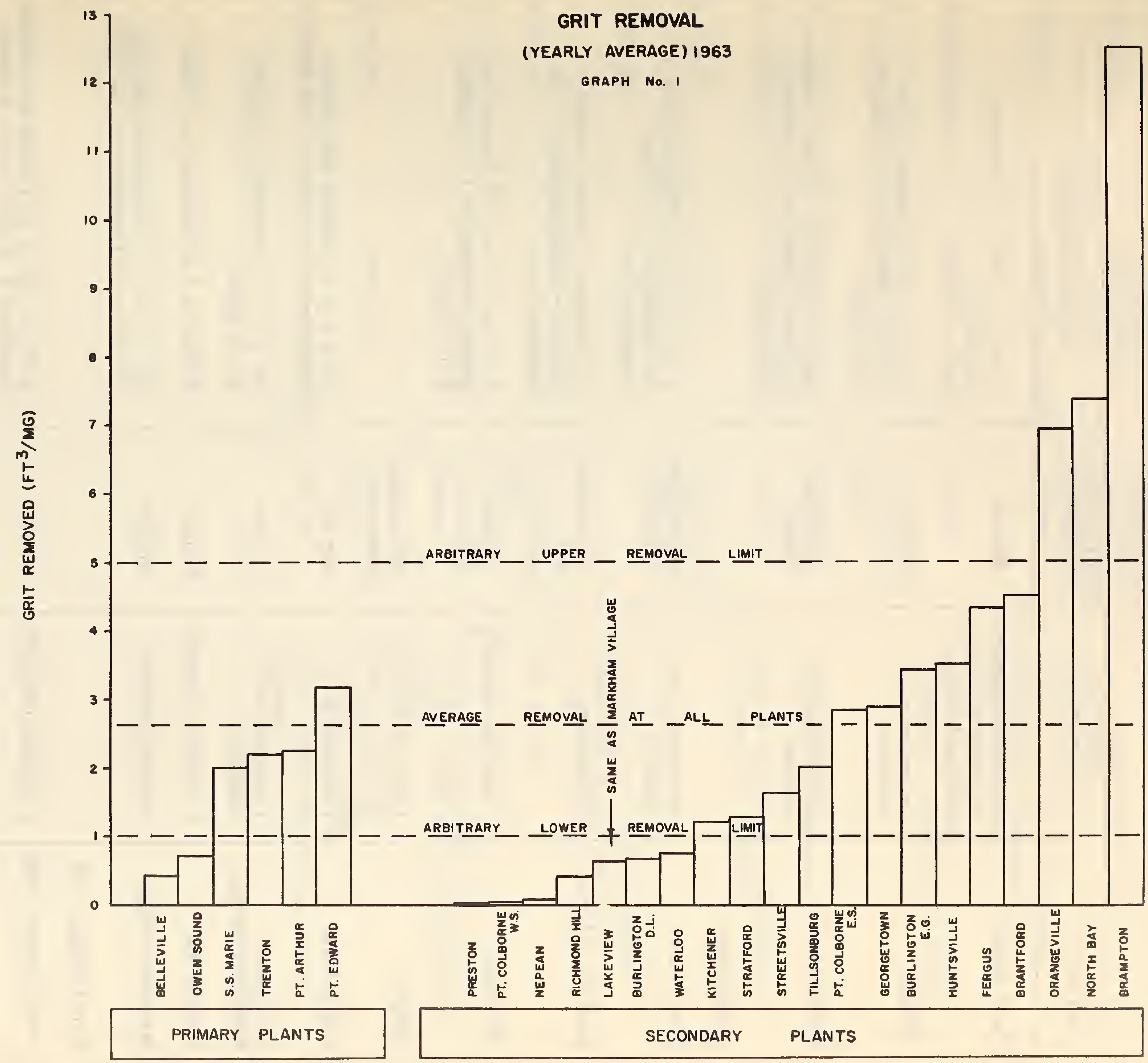
Grit removal data is incomplete.

Burlington Drury Lane

The plant is hydraulically overloaded 25 percent of the time. The grit removal facilities may be inadequate for the flows being received.

No attempt has been made to evaluate the efficiency of grit removal nor the quality of grit being removed in the plants. A few digesters have had to be taken out of service and cleaned due to accumulations of grit and this occurrence may become more prevalent as our plants become older.

Sieve analysis of grit collected will be necessary to properly evaluate the efficiency of removal.


GRIT REMOVAL
(YEARLY AVERAGE) 1963
GRAPH No. 1
GRIT REMOVED (FT3/MG)
13
12
11
10
9
8
7
6
5
4
3
2
1
0
ARBITRARY UPPER REMOVAL LIMIT
AVERAGE REMOVAL AT ALL PLANTS
ARBITRARY LOWER REMOVAL LIMIT
SAME AS MARKHAM VILLAGE
BELLEVILLE
OWEN SOUND
S.S. MARIE
TRENTON
PT. ARTHUR
PT. EDWARD
PRESTON
PT. COLBORNE W.S.
NEPEAN
RICHMOND HILL
LAKEVIEW
BURLINGTON D.L.
WATERLOO
KITCHENER
STRATFORD
STREETSVILLE
TILLSONBURG
PT. COLBORNE E.S.
GEORGETOWN
BURLINGTON E.G.
HUNTSVILLE
FERGUS
BRANTFORD
ORANGEVILLE
NORTH BAY
BRAMPTON
PRIMARY PLANTS
SECONDARY PLANTS

SUMMARY OF GRIT REMOVAL FACILITIES

PROJECT	REMOVAL FACILITIES	COLLECTION FACILITIES	DESIGN CRITERIA
Point Edward	2-parallel channels equipped with proportional weirs.	Manual	2 (16' x 1.75' x 2') velocity of 1 f.p.s.
Trenton	1-Aerated grit chamber	Air lift	1-' x 9' x 8'-6" Volume 4,775 gallons - Retention 6.9 minutes at 1 MGD.
Belleville	1-Aerated grit chamber	Clamshell Bucket	24' x 14' x 12'-6" Volume 26,200 gallons - Retention 12.5 minutes at 3 MGD.
Owen Sound			
Port Arthur	2-Parallel grit channels	Mechanical scrapers	2 (35' x 3' x 5') Retention time 4.7 minutes at 2 MGD per channel.
Sault Ste. Marie	2 Detritors	Mechanical rake	18' diameter, volume of 6240 gallons - Retention time = 1.13 minutes.
Huntsville	2 parallel channels	Manual	2 (10' x 1'-7" x 3.5') Volume 322 gallons - Detention 1.9 minutes @ 0.25 MGD.
Fergus	1 Type T detritor	Mechanical rake	
Tillsonburg	1 Aerated grit	Air lift	13' x 6' x 8' Volume 3900 gallons Retention 8.4 minutes at .665 MGD.
Burlington Elizabeth Gardens	1 Aerated grit chamber	Air lift	14' x 8' x 7' Retention 10 minutes at .75 MGD.
Streetsville	2 parallel channels	Manual	Retention 0.43 minutes at .8 MGD.
Markham Village	Aerated grit tank	Air lift	13' x 6' x 8.1' Volume 4240 gallons Retention 18.4 minutes at .333 MGD.
Port Colborne (ES)			
Port Colborne (WS)	2 parallel channels	Manual	2 (40' x 1' 10" x 1') Volume 419 gallons Retention @ .9 MGD = 0.67 minutes.
Orangeville	2 parallel channels	Manual	2 (25' x 1.9')
Georgetown	Detritor	Mechanical Rake	12' square

(Cont'd)

PROJECT	REMOVAL FACILITIES	COLLECTION FACILITIES	DESIGN CRITERIA
Nepean	2 parallel channels	Manual	2 (35.5' x 3.5' x 1.5') Volume 1080 gallons - Retention 1.2 minutes at 1.5 MGD.
Richmond Hill	Aerated grit tank	Air lift	15.5' x 6'x9' Volume 5220 gallons Retention 4.7 minutes at 1.6 MGD.
Preston	Detritor	Mechanical rake	
Brampton	Aerated grit tank	Air lift	Retention 5 minutes at 2 MGD.
Burlington D. L.	3 parallel channels	Manual	Volume 461 gallons - Retention 0.3 minutes at 2.5 MGD.
Stratford	1 Detritor	Mechanical rake	
North Bay	2 Detritors		2 (11.5' x 11.5' x 2.0') Volume 3300 gallons - Retention 1.2 minutes at 4 MGD.
Waterloo	1 Detritor	Mechanical rake	12' square.
Lakeview	Aerated grit tank	Clamshell bucket	(14' x 15.5' x 11') Volume 14,800 gallons - Retention 4.3 minutes at 5 MGD.
Brantford	2 Detritors	Mechanical rake	20' square x 5'. velocity = 1 f.p.s.
Kitchener	2 aerated grit tanks	Air lift	2 (16' x 10' x 12') Volume 23,000 gallons.

PLANT LOADINGS

HYDRAULIC

The 24 hour maximum daily flow at most of the plants exceeded its hydraulic design capacity and, at several, the average daily flow per month exceeded the design hydraulic capacity of the plant. It is expected that the hydraulic capacity of a plant will be exceeded occasionally on a one day basis. However, flows which exceed the design capacity of a plant on a monthly basis are not to be expected and usually indicate hydraulic overload.

The following table, taken from the ASCE (American Society of Civil Engineers) Design Manual #9, indicates the maximum daily 24 hour flow to be expected for various sizes of installations receiving domestic sewage only:

Average Flow (MGD U.S.)	Max. Expected Flow (MGD U.S.)	Average Flow (MGD U.S.)	Max. Expected Flow (MGD U.S.)
0.3	0.75	5	7.25
0.5	1.15	6	8.1
1	2	7	9.1
2	3.4	8	10.0
3	4.8	9	11.0

Plants which received flows in excess of the maximum expected flows, as indicated in the above Table, were Trenton, Owen Sound, Sault Ste. Marie, Port Arthur, Burlington Elizabeth Gardens, Markham, Port Colborne, W. S., Georgetown, Richmond Hill, Stratford, North Bay, Waterloo, Brantford and Kitchener. It is probable that these plants receive storm flows, industrial wastes or excess infiltration.

The relationship between the maximum daily and average daily flows for the various plants is shown on Graph No 2; as indicated by the graph the maximum 24 hour

flow (storm flow) received at Stratford is greater relative to design flow (418 percent of design) than that for any other plant. The percent of time which daily flows are in excess of design indicates that three plants (Belleville, Trenton and Nepean) have flows which are in excess of their design flows more than one-half of the time. On a 24 hour flow basis 10 of the 27 plants never received flows in excess of their designs.

A summary of the data relating to flows at the various projects is shown in Table 1. The column of "% of Time Flow Greater Than Design" was derived from the probability plots of daily flows for each project as shown in the project annual reports. These curves were based upon data collected for 365 days at each plant.

Twelve of the probability plots shown in the project annual reports were not straight lines. This indicates that the flows at these plants were not normally distributed, which was probably a result of storm flows.

The average daily flows for the year for 4 plants (Trenton, Belleville, Owen Sound and Nepean) exceeded the respective design hydraulic capacity of the plants. As indicated in the column "Average Daily Flow as % of Design" (Table 1) most of the flows experienced at plants on a yearly basis were well below the design capacity.

BOD AND SUSPENDED SOLIDS

The BOD and Suspended Solids loading data as shown in Table 1 and Graph No. 3 is based upon the product of the average daily flow for the year and the average concentration of BOD and suspended solids respectively. No attempt has been made to determine loadings for shorter periods of time due to the limited number of samples. Most of the plants were sampled 26 times during the year.

On this basis, Burlington Elizabeth Gardens had a 36 percent overload with respect to BOD; Waterloo experienced a 39 percent BOD and a 5 percent suspended solids overload; Belleville a 23 percent overload with respect to suspended solids; and Trenton had a 58 percent overload of suspended solids.

OWRC WATER POLLUTION CONTROL PLANTS

TABLE 1

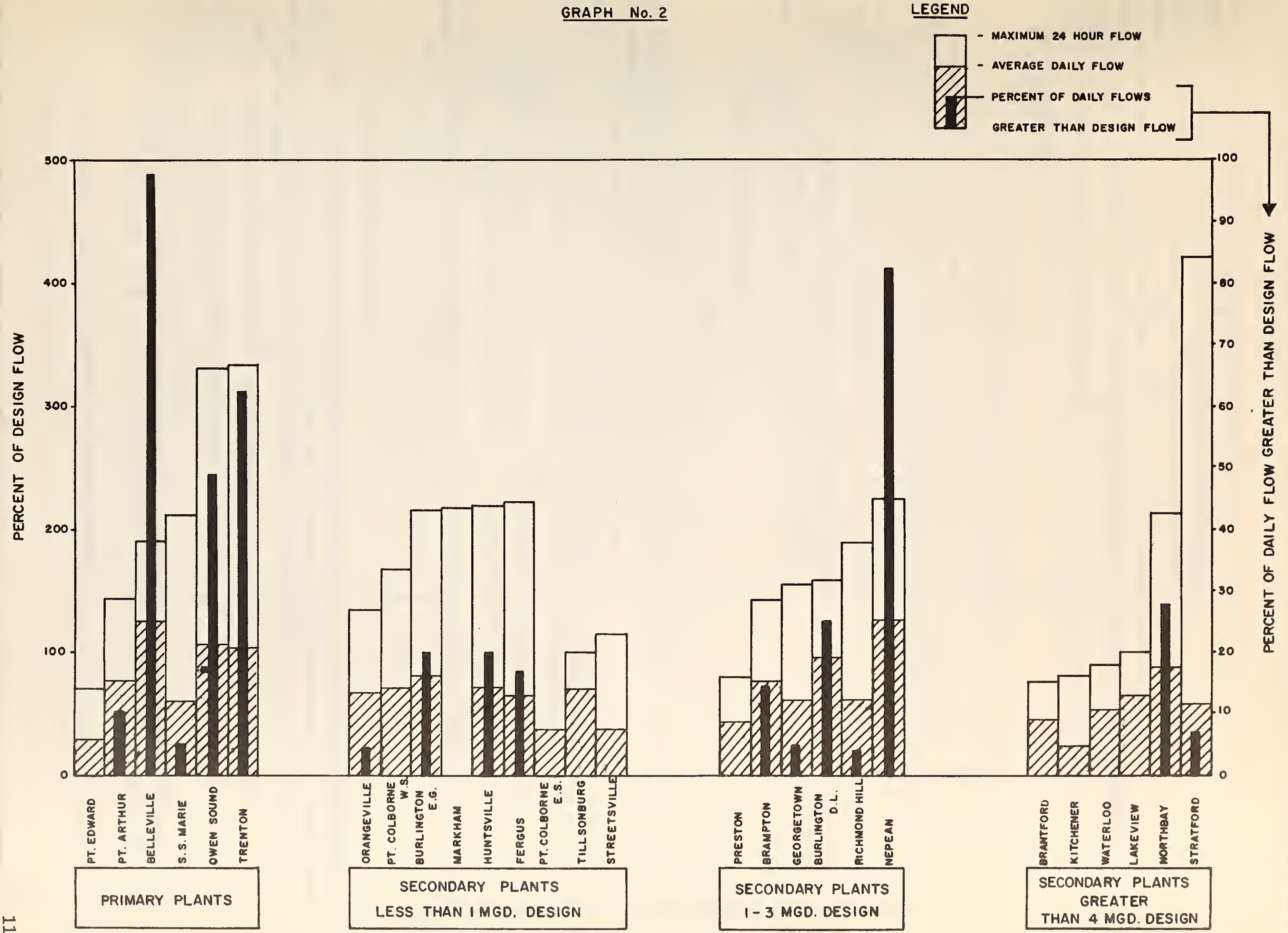
HYDRAULIC, BOD AND SUSPENDED SOLIDS LOADINGS

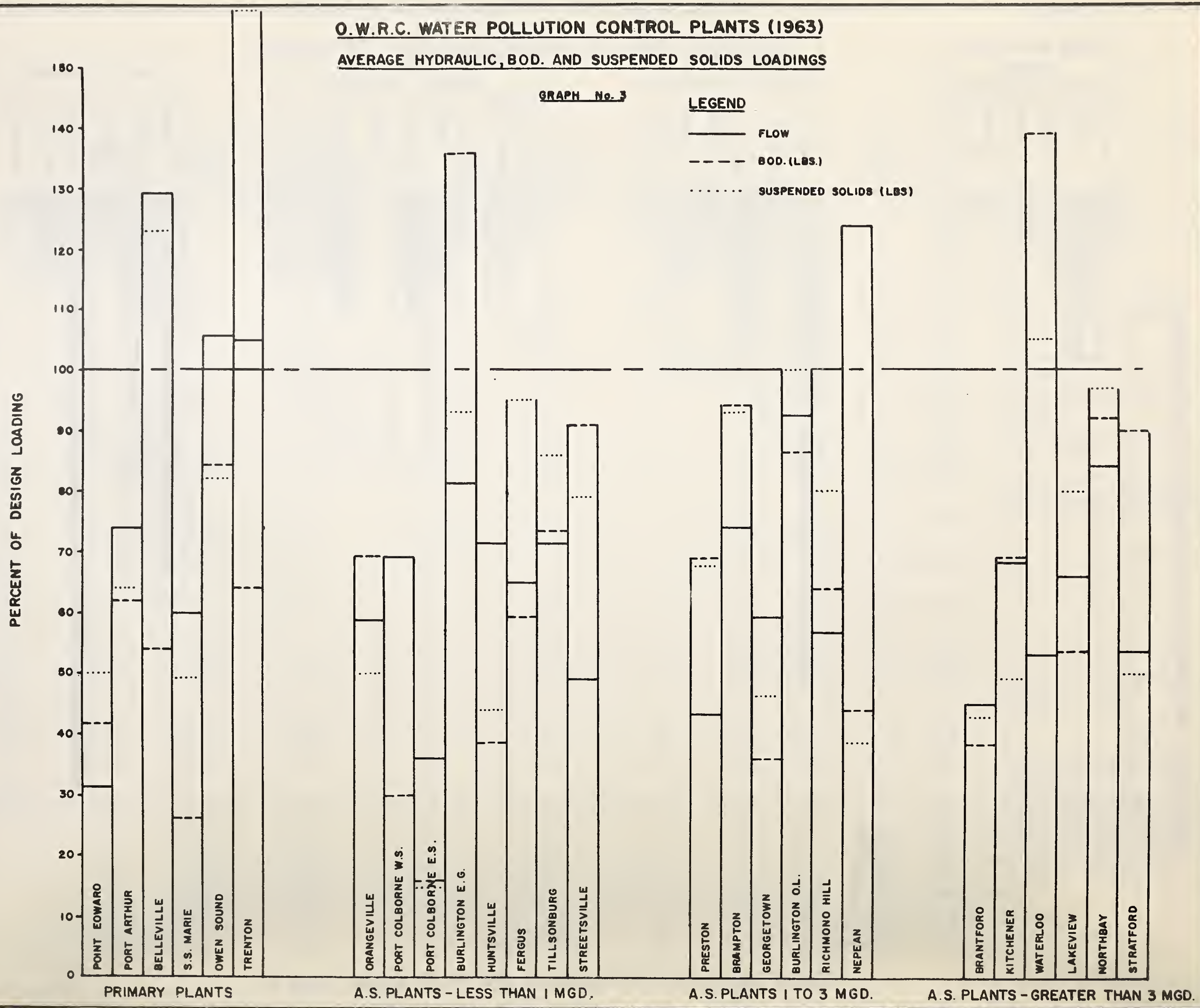
1963

Project	Type	Design Flow (mgd)	Actual Yearly flow (mgd)	% of time flow greater than design	Av. daily flow as % of design	BOD (lbs) as a % of design	SS (lbs) as a % of design	Max. Daily flow (mgd)	Max. monthly Ave. flow (mgd)	Remarks
Point Edward	Primary	0.57	0.177	Nil	31	43	50	0.38 (Mar)	0.224 (Mar)	
Trenton	"	1.0	1.05	62	105	63	158	3.34 (Aug)	1.55 (Mar)	Hyd. & SS overload
Belleville	"	3.0 & 9.0	3.84	97	128	54	123	5.3 (Aug)	4.28 (Aug)	Hyd. & SS overload
Owen Sound	"	3.0	3.19	48	106	84	82	10.0 (Mar)	4.40 (Mar)	Hyd. overload
Port Arthur	"	4.0	2.92	11	73	61	63	5.7 (June)	3.77 (Oct)	Storm water
S.S. Marie	"	8.0	4.83	5.5	60	27	49	16.6 (Apr)	7.20 (Mar)	Spring hyd. overload
Huntsville	A.S.	0.25	0.178	20	71	38	43	0.54 (Mar)	0.215 (Aug) (July)	Periodic hyd. overload
Fergus	"	0.6	0.39	16.5	65	59	95	1.34 (May)	0.67 (May)	Spring hyd. overload
Tillsonburg	"	0.665	0.474	Nil	71	73	86	0.67 (May)	0.54 (May)	
Burlington - E.G.	"	0.75	0.606	20	81	136	92	1.6 (Apr)	1.00 (May)	Spring hyd. overload and organic overload
Streetsville	"	0.8	0.385	Nil	48	91	78	0.9 (June)	0.50 (Aug)	
Markham	"	0.334	0.135	-	40	-	-	0.72 (Apr)	-	
Port Colborne E.S.	-"	0.85	0.304	Nil	36	16	15	0.562 (Mar)	0.503 (Mar)	
Port Colborne W.S.	-"	0.9	0.62	Nil	69	30	24	1.5 (Dec)	0.94 (Mar)	
Orangeville	"	0.75	0.442	4	59	68	50	0.99 (Mar)	0.66 (May)	
Georgetown	"	1.5	0.89	4.5	59	37	47	2.28 (Mar)	1.23 (Mar)	
Nepean	"	1.5	1.86	82	124	44	38	3.4 (Mar)	2.40 (May)	Excessive hyd. overload
Richmond Hill	"	1.6	0.905	Nil	57	64	80	3.0 (Mar)	1.31 (Mar)	
Preston	"	1.8	0.80	Nil	43	69	68	1.4 (Mar)	1.0 (Mar)	
Brampton	"	2.0	1.48	14	74	93	93	2.93 (May)	2.04 (Oct)	Approaching design capacity
Burlington D.L.	"	2.5	2.31	25	92	87	100	3.8 (Apr)	3.41 (Apr)	App. design capacity
Stratford	"	4.0	2.12	6	53	90	50	16.8 (Mar)	4.3 (Mar)	Excessive storm flow
North Bay	"	4.0	3.38	28	84	92	97	8.7 (Mar)	4.34 (May)	App. design capacity
Waterloo	"	4.0	2.09	Nil	52	139	105	3.77 (Mar)	2.39 (Mar)	Organic overload
Lakeview	"	5.0	3.40	0.3	66	54	80	5.0 (Aug)	3.78 (May)	
Brantford	"	12.5	5.59	NIl	45	38	43	9.5 (Mar)	6.38 (May)	
Kitchener	"	13.5	7.8	Nil	68	69	48	11.13 (Jan)	9.02 (Jan)	
Westminster	T.O.	0.250	0.062	Nil	25	19	16	0.138 (Dec)	0.10 (Dec)	

O.W.R.C. WATER POLLUTION CONTROL PLANTS FLOWS (1963)

GRAPH No. 2




O.W.R.C. WATER POLLUTION CONTROL PLANTS (1963)
AVERAGE HYDRAULIC, BOD. AND SUSPENDED SOLIDS LOADINGS
GRAPH No. 3
LEGEND
FLOW
BOD. (LBS.)
SUSPENDED SOLIDS (LBS)
PERCENT OF DESIGN LOADING
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
POINT EDWARD
PORT ARTHUR
BELLEVILLE
S.S. MARIE
OWEN SOUND
TRENTON
ORANGEVILLE
PORT COLBORNE W.S.
PORT COLBORNE E.S.
BURLINGTON E.G.
HUNTSVILLE
FERGUS
TILLSONBURG
STREETSVILLE
PRESTON
BRAMPTON
GEORGETOWN
BURLINGTON O.L.
RICHMOND HILL
NEPEAN
BRANTFORD
KITCHENER
WATERLOO
LAKEVIEW
NORTHBAY
STRATFORD
PRIMARY PLANTS
A.S. PLANTS - LESS THAN 1 MGD.
A.S. PLANTS 1 TO 3 MGD.
A.S. PLANTS - GREATER THAN 3 MGD.

REMOVAL EFFICIENCY

Table No. 3 is a summary of the 1963 sampling results for all plants having an annual report. All figures are obtained from monthly plant averages where averages are available.

Only the two generally classified sewage treatment processes of primary and secondary were considered.

Primary treatment can usually be expected to remove 50 to 60 per cent suspended solids and 25 to 35 per cent BOD.

Secondary treatment using the activated sludge process may remove up to 90 per cent of suspended solids and 75 to 90 per cent BOD.

Primary Plant Removals

Point Edward's BOD removal efficiency fell within the accepted range while all other plants had greater removal efficiencies. These exceptional removal efficiencies were all due to the very weak raw sewage BOD.

All plants had a suspended solids removal equal to or better than the expected range.

On both Graph No. 5 and Graph No. 6 it can be noted that the per cent removal efficiencies of primary plants are extended over a very wide range in comparison to the secondary plants due to the lack of operating controls.

Secondary Plant Removals

All true secondary plants except Nepean had BOD removal efficiencies equal to or greater than the normally expected ranges. The poor performance of the Nepean plant is due to the extremely low BOD of the raw sewage which averaged only 54 ppm.

The very high BOD of the raw sewage to the plants in Waterloo and Preston resulted in poor quality final effluent in spite of very good removal efficiencies.

The removal efficiency of suspended solids in all secondary plants extended over a much wider range than the BOD. Of the twenty-two secondary plants 60 per cent exceeded 90 per cent removal as an average.

General

From the Table No. 3 and Graphs No. 5 and 6 it can be seen that removal efficiencies can only be used as a general guide in reviewing the performance of plants. The strength of the raw sewage is a significant factor in the performance of any plant.

In order to maintain the OWRC objective of 15 ppm. of BOD and S. S. in the final effluent of secondary plants with a removal efficiency of 90 per cent, the strength of the raw sewage should not exceed 300 ppm.

It can be seen from Table No. 3 that the average strength of raw sewage reaching OWRC plants is 250 ppm. of BOD and 268 ppm. of S. S. This would seem to indicate that the commonly used figures of 200 ppm. BOD and S. S. should be discarded and each municipality be sampled to determine sewage strength in advance of any design.

On the average the OWRC secondary plants had an effluent BOD and S. S. of 20 and 21, both of which exceeded the OWRC's objective of 15 ppm. It is felt that this failure to meet objectives was due to the high strength of the raw sewage at a few plants because the removal efficiencies averaged 90 per cent for BOD and 91 per cent for suspended solids

Omitting Kitchener and Orangeville 9 of the 20 secondary plants (45 per cent) had an effluent BOD below 15 ppm. and 5 of the 20 secondary plants (25 per cent) had an effluent S. S. below 15 ppm.

REMOVAL EFFICIENCY

TABLE NO. 3

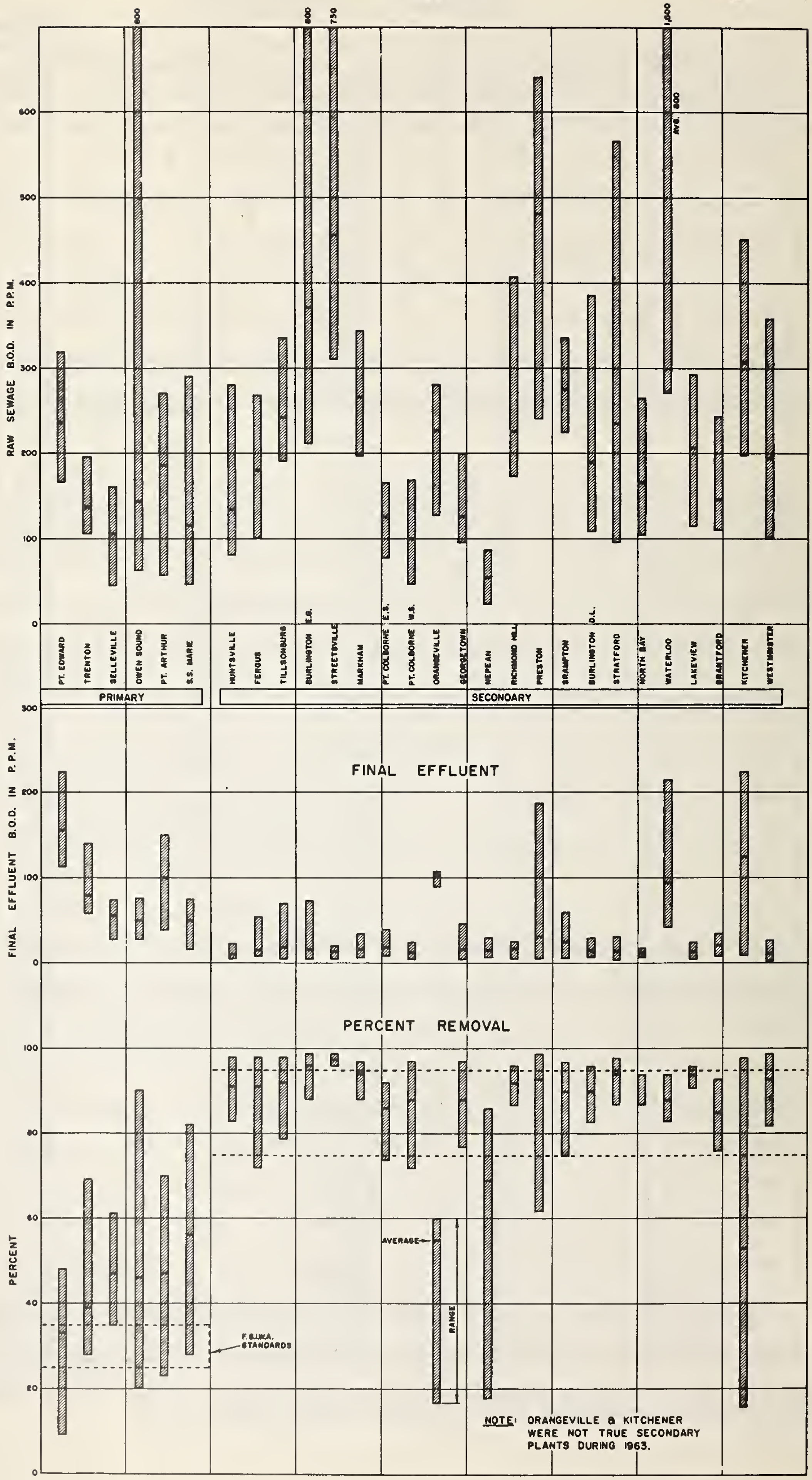
PROJECT	BIOCHEMICAL OXYGEN DEMAND (PPM)									SUSPENDED SOLIDS (PPM)								
	RAW			FINAL			REMOVAL			RAW			FINAL			REMOVAL		
PRIMARY	MAX	MIN	AV.	MAX	MIN	AV.	MAX	MIN	AV.	MAX	MIN	AV.	MAX	MIN	AV.	MAX	MIN	AV.
POINT EDWARD	320	165	236	225	112	156	48	9	33	552	236	323	91	51	74	88	70	74
TRENTON	195	104	137	140	58	79	69	28	39	558	114	276	168	67	85	82	36	59
BELLEVILLE	160	45	105	74	27	53	61	35	47	279	104	192	118	33	82	83	13	67
OWEN SOUND	800	62	143	76	27	49	90	20	46	240	94	155	106	36	66	82	26	55
PORT ARTHUR	270	56	187	148	39	99	70	23	47	294	162	238	158	56	97	75	41	58
SAULT STE. MARIE	290	46	113	75	15	50	82	28	56	445	78	163	65	26	44	94	33	73
AVERAGE	339	80	154	123	46	81	70	24	45	395	131	224	118	45	75	84	36	64
SECONDARY																		
HUNTSVILLE	280	80	133	21	5	9	98	83	91	391	60	152	24	4	10	98	78	90
FERGUS	268	101	180	53	7	14	98	72	91	376	170	280	56	9	26	98	70	89
TILLSONBURG	335	190	242	70.0	5	19	98	79	92	554	200	300	33	4	16	98	85	95
BURLINGTON EG.	800	213	370	72	4	16	99	88	96	515	148	283	75	3	17	99	83	94
STREETSVILLE	730	320	456	20	4	13	99	96	97	576	284	425	25	2	12	99	95	97
MARKHAM	342	196	266	35	7	17	72	88	94	386	214	295	52	14	33	94	78	89
PORT COLBORNE ES	165	78	125	39	9	18	92	74	86	176	91	128	36	10	17	93	60	85
PORT COLBORNE WS	169	46	100	24.0	4	11	97	72	88	214	65	106	33	2	12	98	60	89
ORANGEVILLE *	280	128	228	108	90	103	60	17	55	260	146	207	92	42	65	80	37	68
GEORGETOWN	198	95	125	46	4	16	97	77	88	366	125	197	33	6	16	97	75	91
NEPEAN	86	22	54	30	8	14	86	18	69	151	45	90	28	5	19	95	54	78
RICHMOND HILL	406	172	225	27	6	18	96	87	92	588	196	309	45	5	22	98	88	93
PRESTON	640	240	480	188	6	31	99	62	93	900	282	551	166	4	27	99	66	94
BRAMPTON	335	223	273	60	7	24	97	74	90	513	226	316	96	13	34	96	61	88
BURLINGTON DL.	385	108	189	29	8	17	96	83	90	347	159	217	35	11	18	96	82	91
STRATFORD	565	96	233	32	4	13	98	82	94	358	150	232	16	2	11	99	92	95
NORTH BAY	263	103	164	19	9	13	94	87	92	388	97	229	51	4	18	98	62	89
WATERLOO	1500	270	798	216	42	95	94	83	88	940	279	545	79	1	51	96	84	91
LAKEVIEW	292	114	206	24	6	13	96	91	94	352	134	244	27	7	17	96	88	93
BRANTFORD	242	110	145	36	9	22	93	26	85	228	134	169.5	38	2	14	98	78	92
KITCHENER *	450	197	307	226	10	127	98	16	53	420	214	324	179	13	100	96	34	65
WESTMINSTER	358	100	193	28	2	12	99	82	93	622	64	299	139	5	34	98	75	89
AVERAGE	413	146	250	53	8	20	96	78	90	437	158	268	54	6	21	97	76	91

NOTE: VALUES FOR FINAL EFFLUENT AND REMOVALS FOR KITCHENER AND ORANGEVILLE ARE NOT INCLUDED IN THE AVERAGE BECAUSE THE PLANTS WERE NOT TRUE SECONDARY TREATMENT PLANTS IN 1963.

BIOCHEMICAL OXYGEN DEMAND

REMOVAL EFFICIENCY
1963

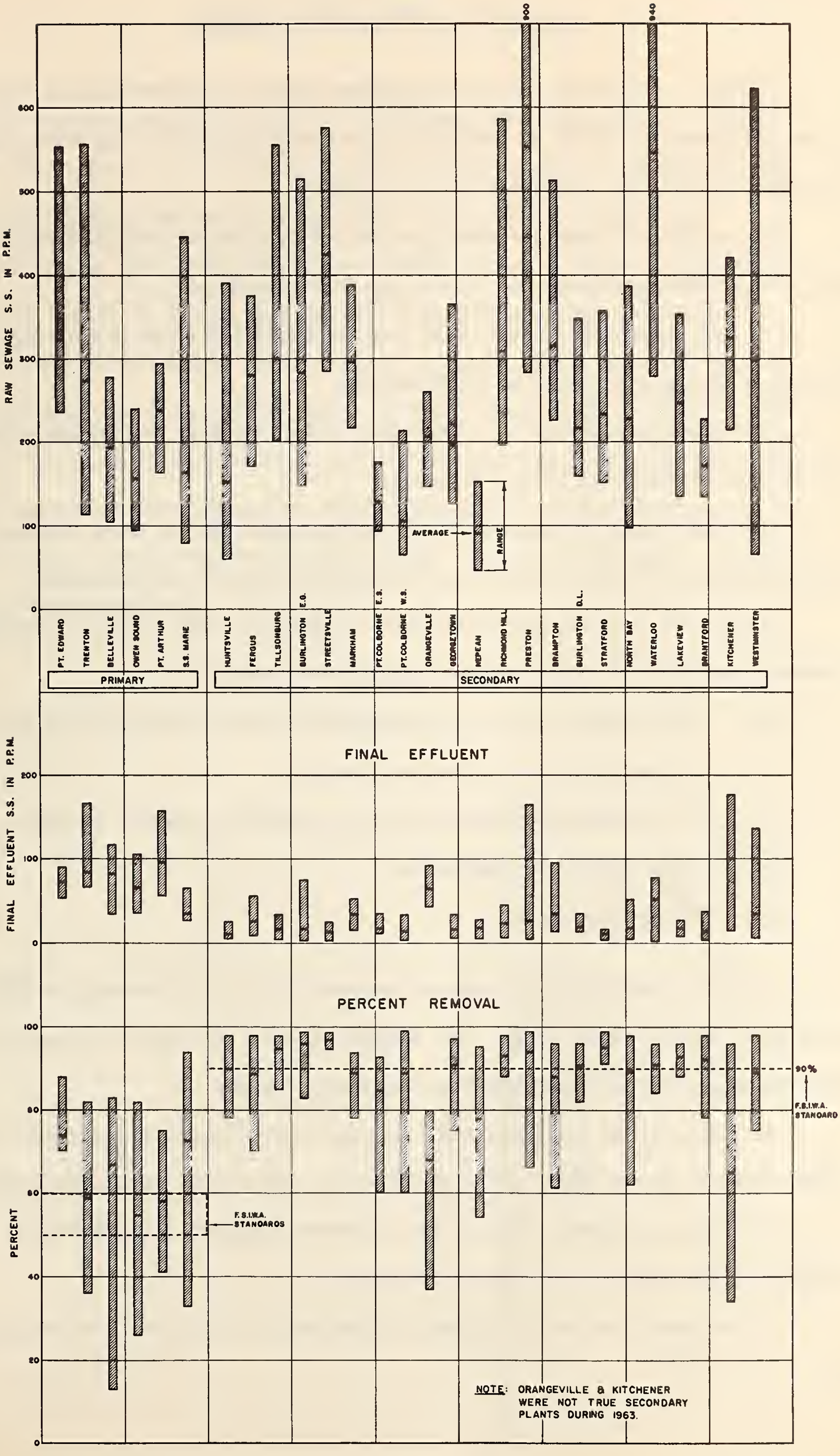
GRAPH Nº 4



SUSPENDED SOLIDS

REMOVAL EFFICIENCY
1963

GRAPH Nº 5



AERATION TANK PERFORMANCE

Table 3 is a summary of the significant data on aeration tanks contained in the 1963 reports. Graph 6 indicates the air requirements for the various plants in comparison with the commonly accepted ranges..

Most of the diffused air plants use far too much air for the BOD removed. The A. S. C. E. Design Manual No. 8 gives the following ranges:

At a loading of 30 - 50 lbs. BOD per 100 lbs. MLSS there is 500 - 700 cubic feet of air required per pound of BOD removed.

At loading less than 30 lbs. BOD per 100 lbs. MLSS up to 1800 cubic feet of air is required per pound of BOD removed.

The most flagrant examples of overaeration according to these standards are Tillsonburg, Stratford, North Bay, Markham, Lakeview and Brantford.

There are varied reasons that can be suggested for the overuse of air but the problems appear to be a combination of the following factors:

a) Plants which are not up to design loading but which must keep the complete aeration section in service.

b) The maintaining of higher MLSS to reduce the tendency to foam.

c) The aeration tank dimensions.

d) The use of Sparjers.

Aeration tank efficiencies can be increased by either increasing the BOD loadings or decreasing the MLSS. The situation at each plant must be assessed in order to determine the possibilities of such improvements.

Brampton is the only plant which appears to be biologically overloaded at 95 lbs. of BOD per 100 lbs. of MLSS. The low MLSS are responsible for the high loading.

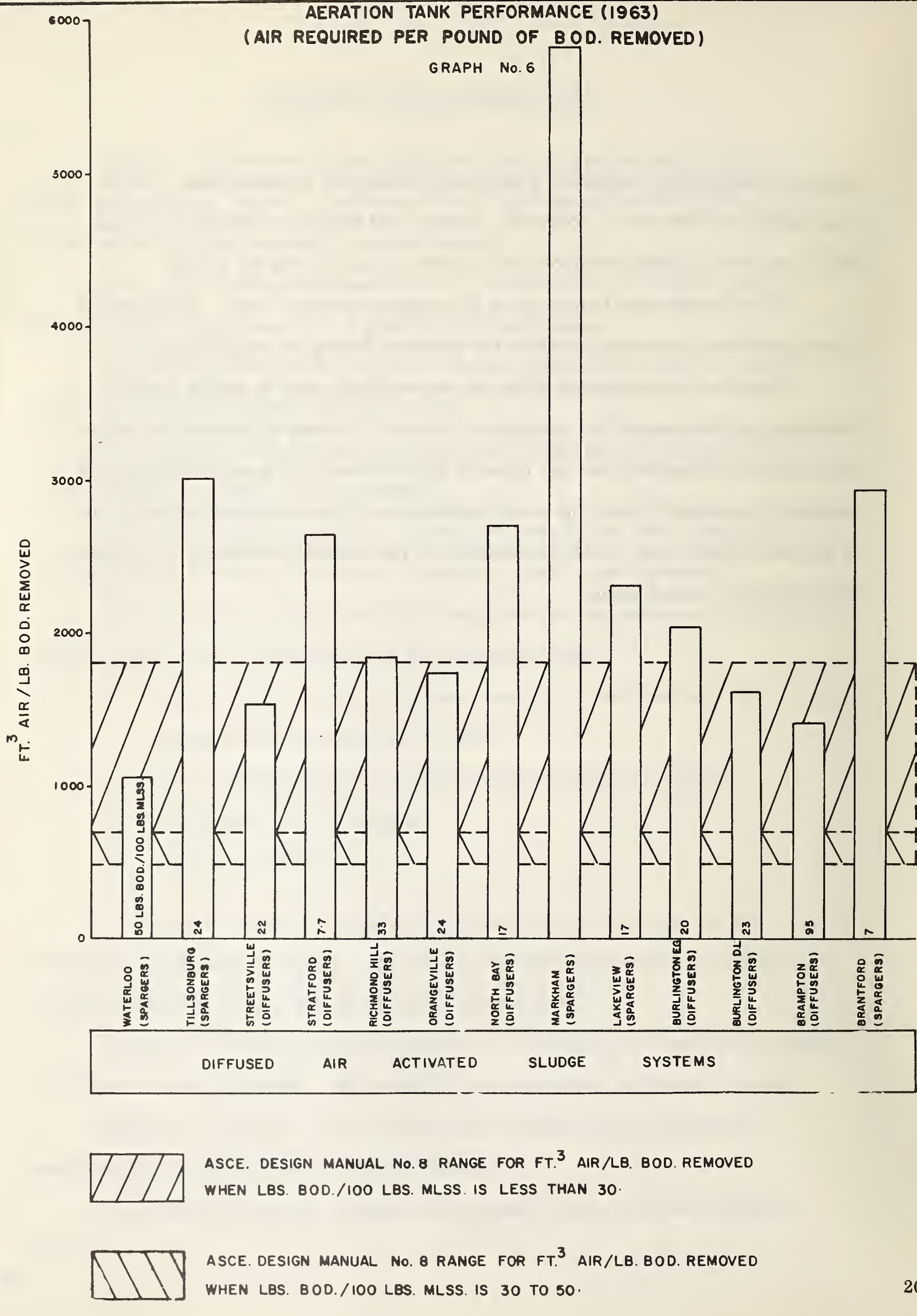
Waterloo is operating close to the maximum efficiency and will require additional air to increase the removal efficiency.

On an annual flow basis, Nepean and Burlington Drury Lane have marginal

aeration tank detention especially if the return sludge flow is appreciable. Due to high spring flows Stratford, North Bay, Fergus, and Burlington Elizabeth Gardens, have very short aeration detentions for a month or more during the spring.

Return sludge data is not kept on the monthly summary cards. Therefore, it is not possible to accurately calculate the hydraulic loading on the aeration tank.

There are no parameters which can be practically used to assess the performance and efficiency of the mechanical aerators. It would be desirable to be able to record the horsepower used per pound of BOD removed, but none of the plants are equipped to separately meter the power consumption of the mechanical aerators. It is felt that periodic tests should be conducted of the oxygenation capacity of the mechanical aerators in each plant.


AERATION TANK PERFORMANCE (1963)
(AIR REQUIRED PER POUND OF B.O.D. REMOVED)
GRAPH No. 6
FT.3 AIR / LB. BOD. REMOVED
6000
5000
4000
3000
2000
1000
0
50 LBS. BOD./100 LBS. MLSS
24
22
7·7
33
24
17
17
20
23
95
7
WATERLOO (SPARGERS)
TILLSONBURG (SPARGERS)
STREETSVILLE (DIFFUSERS)
STRATFORD (DIFFUSERS)
RICHMOND HILL (DIFFUSERS)
ORANGEVILLE (DIFFUSERS)
NORTH BAY (DIFFUSERS)
MARKHAM (SPARGERS)
LAKEVIEW (SPARGERS)
BURLINGTON EG (DIFFUSERS)
BURLINGTON DL (DIFFUSERS)
BRAMPTON (DIFFUSERS)
BRANTFORD (SPARGERS)
DIFFUSED AIR ACTIVATED SLUDGE SYSTEMS
ASCE. DESIGN MANUAL No. 8 RANGE FOR FT.3 AIR/LB. BOD. REMOVED WHEN LBS. BOD./100 LBS. MLSS. IS LESS THAN 30·
ASCE. DESIGN MANUAL No. 8 RANGE FOR FT.3 AIR/LB. BOD. REMOVED WHEN LBS. BOD./100 LBS. MLSS. IS 30 TO 50·

AERATION TANK PERFORMANCE 1963

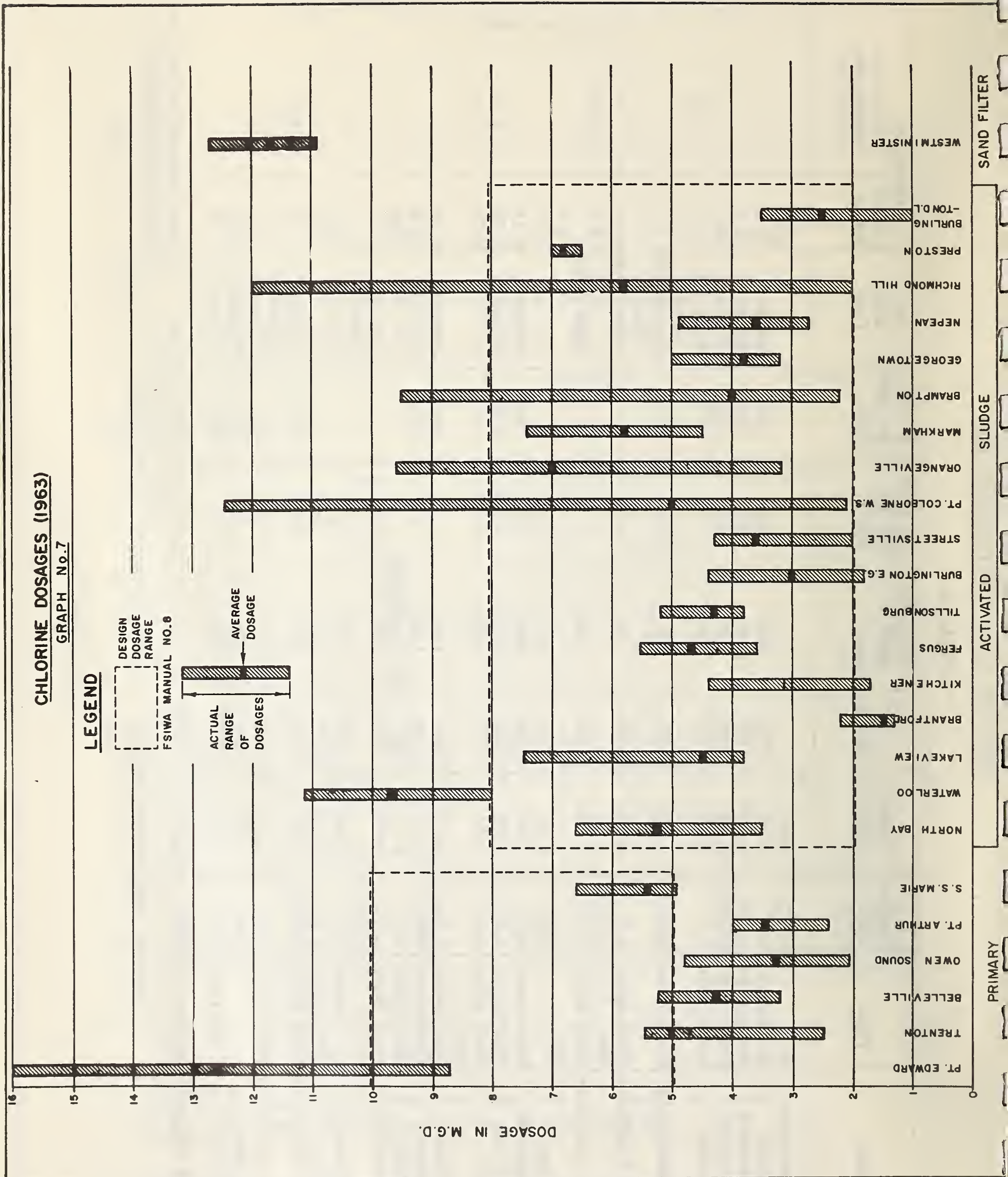
TABLE 3

Project	Type	Design Flow	Actual Flow	MLSS	Prim. Eff. BOD, ppm	lbs. BOD 100 lbs. MLSS	ft.^{3} Air lbs. BOD Rem.	Air Intro. Type	Detention Design Hours	Detention Det. at max. monthly flow 25% Return
Westminster	TO	0.25	0.06						24.2	
Waterloo	Bisorption	4.0	2.09	1791	652	50	1057	Sparger	7.2	
Tillsonburg	Single pass	0.665	0.474	1155	169	24	3010	Sparger	10.1	
Streetsville	Single pass	0.800	0.384	2066	266	22	1538	Diffuser	6.1	
Stratford	Single pass	4.0	2.12	2513	95	7.7	2619	Dome Diffuser	5.7	4.3
Richmond Hill	Single pass	1.6	0.905	1368	147	33	1817	Carbon Diffuser	5.9	
Port Colborne - WS	Mech aeration	0.9	0.618	1365	62	20	-	Ames Crosta 6	6.7	6.6
Port Colborne - ES	Mech aeration	0.85	0.304	3073	124.9	5.9	-	Ames Crosta 4	6.0	
Preston	" "	1.8	0.80	2045	204	17	-	A. C. 6	9.7	
Orangeville	Single pass	0.75	0.44	1214	144	24	1736	Diffusers	2.14*	
North Bay	Single pass	4.0	3.38	1341	63.7	17.3	2706	Diffusers	5.31	4.9
Nepean	Mech aeration	1.5	1.86	1775	43	15	-	A. C. 6	6.75	3.4
Markham	Single pass	0.334	0.165	2329	130	-	5803	Spargers	6.06	
Lakeview	Three pass	5.0	3.4	1739	128	17	2312	Spargers	6.0	
Kitchener	Mech. aera.	13.5	7.8	No	date available			A. C. 56	5.85	
Huntsville	Mech. aera.	0.25	0.179	721	123	30	-	Chicago Pump 2	6.75	7.7
Georgetown	Mech. aera.	1.5	0.89	1627	79	10	-	A. C. 8	8.0	
Fergus	Mech. aera.	0.6	0.392	1377	114	23.3	-	A. C. 3	4.4	3.3
Burlington E. G.	Single pass	0.75	0.606	2272	212	20	2027	Coliflex Diffusers	6	5.3
Burlington D. L.	Triple pass	2.5	2.31	1731	141	23	1603	Diffusers	7.4	4.4
Brampton		2.0	1.475	735	153	95	1402	Diffusers	10.2	
Brantford	Triple pass	12.5	5.59	2648	98	7	2953	Spargers	6	

ASCE Recommendations: 30-50 lbs. BOD/100 lbs. MLSS ----- 500-700 ft.^{3} air/lb. BOD removed -

<30 lbs. BOD/100 lbs. MLSS ----- up to 1800 ft.^{3} air/lb. BOD

* Cannot calculate since do not know return sludge rate


CHLORINE DOSAGES (1963)
GRAPH No.7
LEGEND
DESIGN DOSAGE RANGE
FSIWA MANUAL NO.8
AVERAGE DOSAGE
ACTUAL RANGE OF DOSAGES
DOSAGE IN M.G.D.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
PT. EDWARD
TRENTON
BELLEVILLE
OWEN SOUND
PT. ARTHUR
S.S. MARIE
NORTH BAY
WATERLOO
LAKEVIEW
BRANTFORD
KITCHENER
FERGUS
TILLSONBURG
BURLINGTON E.G.
STREETSVILLE
PT. COLBORNE W.S.
ORANGEVILLE
MARKHAM
BRAMPTON
GEORGETOWN
NEPEAN
RICHMOND HILL
PRESTON
BURLING -TON D.L.
WESTMINISTER
PRIMARY
ACTIVATED SLUDGE
SAND FILTER

CHLORINATION

Table 4 is a summary of the significant data on chlorination contained in the 1963 reports. Graph 7 indicates the average dosage and the ranges of chlorine dosages for the various plants in comparison with the commonly accepted ranges.

CHLORINE DOSAGES

The ASCE Design Manual No. 8 gives the following ranges of chlorine dosages required for disinfection;

Settled sewage	5-10 mg/l
Activated sludge effluent	2-8 mg/l
Sand filter effluent	1-5 mg/l

PRIMARY PLANTS

Point Edward with an average dosage of 12.6 mg/l is the only primary plant which exceeds the ASCE range. This high dosage is due to inability to continuously control the small dosages required at the plant. The limited supervision at the plant makes frequent adjustments difficult so that dosage is kept high to meet the minimum requirements of 0.5 mg/l at all times.

The cause of the low dosages at Belleville and Owen Sound are due to the insufficient detention capacity and the inability of getting a 15 minute residual.

ACTIVATED SLUDGE PLANTS

Most of the dosages at the plants fall within the ASCE ranges, the exceptions being Waterloo and Brantford.

The high average BOD and SS in the final effluent from the Waterloo plant should place the plant in the primary effluent range of dosages rather than the activated sludge range.

The Brantford plant uses the starch-iodide test for chlorine residual rather than the orthotolidine method to avoid interference by nitrates. It has been found that a lower chlorine dosage is required.

No readily discernable relationship seems to exist between effluent BOD and SS and the chlorine dosage. Often maximum chlorine dosages were required during the months of maximum effluent BOD or SS and minimum chlorine dosages were required during months of minimum effluent BOD or SS. However, in some cases the reverse was true. The greatest problem in making a proper correlation is the small number of BOD and SS sample results taken in a month. It also is necessary to standardize on the point of sampling before or after chlorination. This information was not available from the annual reports.

At a few of the plants particularly Tillsonburg and Westminster the effluent BOD was reduced considerably as soon as chlorination was started.

It is recommended that as well as chlorine residual, plant effluents be sampled for coliform counts to determine the degree of disinfection. The use of the standard minimum residual of 0.5 for all types of effluents is both arbitrary and meaningless.

SUMMARY CHLORINATION DATA 196[illegible] TABLE 4

PROJECT	TYPE	DESIGN FLOW (MGD)	DESIGN RETENTION (MINS.)	MONTHS OF CHLORIN.	MAX. MONTHLY AV. DAILY FLOW (MGD)	AV. DAILY FLOW (MGD)	MIN. MONTHLY RETENTION (MINS)	AV. RETN. (MINS)	TOTAL FLOW (MG)	TOTAL CHLORINE (LBS.)	MAX. CL. DOSAGE (MG/L)	MIN. CL. DOSAGE (MG/L)	AV. CL. DOSAGE (MG/L)	RESIDUAL (MG/L)
POINT EDWARD	PRIM.	0.57	27	12	0.23	0.178	66	86	64.9	8,070	17.2	8.8	12.6	
TRENTON	"	1.0	37	5	1.47	1.127	26	23	169.1	7,656	6.4	3.4	5.0	0.5
BELLEVILLE	"	3.0	31	4	4.29	3.98	22	23	479.5	19,205	5.2	3.3	4.2	0.5
OWEN SOUND	"	3.0	11.2	7	3.55	3.02	8.6	11	635.1	20,000	4.7	2.1	3.2	0.5
PORT ARTHUR	"	4.0	20	5¼	3.77	3.10	21.5	26	493.9	15,134	4.0	2.1	3.2	0.5
SAULT STE. MARIE	"	8.0	1.5+ OUT-FALL	8	5.45	4.59	2.7+	3.3+	1,123.5	65,330.	6.7	4.9	5.4	
BRAMPTON	AS	2.0	15	9	2.14	1.61	13.2	17.5	435.5	17,000	9.5	2.0	4.0	
HUNTSVILLE	"	0.25	36											
FERGUS	"	0.6	15	7	0.38	0.336	21.5	24.5	70.5	3,333	5.5	3.7	4.7	0.5
TILLSONBURG	"	0.665	30.2	4	0.54	0.48	37.2	41.8	59.2	2,414	5.2	3.8	4.3	0.5
BURLINGTON EG	"	0.75	10+	12	1.01	0.606	7.5+	12.5+	221	1,095	4.4	1.8	3.0	0.5
STREETSVILLE	"	0.8	20	6 1/6	0.50	0.42	32	38	77.5	2,695	4.3	2.0	3.6	
PORT COLBORNE ES	"	0.85		NO CHLORINATION										
PORT COLBORNE WS	"	0.9	16	12	0.77	0.62	18.8	23.3	225.4	10,694	12.5	2.1	5.0	
ORANGEVILLE	"	0.75	29.6	12	0.66	0.44	33.7	50.5	161.5	11,415	9.6	3.2	7.0	
GEORGETOWN	"	1.5	26	7¼	1.17	0.88	33.4	55.2	190.2	7,282	5.0	3.1	3.8	
NEPEAN	"	1.5	17	5	2.4	1.72	10.7	14.9	258.8	8,941	4.9	2.8	4.8	0.5
RICHMOND HILL	"	1.6	11.3	12	1.31	0.91	13.8	19.8	331.4	18,750	12.0	2.0	5.8	
PRESTON	"	1.8	15	4	0.75	0.72	36	37.5	88.0	5,950	7.0	6.6	6.8	0.5
BURLINGTON DL	"	2.5		9	3.30	2.36			637.6	15,889	3.5	1.0	2.5	0.5
NORTH BAY	"	4.0	25	6	4.34	3.48	23.5	29.4	612.4	5,650	6.6	3.5	5.3	0.5
WESTMINSTER	FILTERS	0.25	22.7	5¼	0.064	0.057	88	99	8.9	1,049	12.7	10.1	11.7	0.5
WATERLOO	AS	4.0		3	2.02	1.9			172.9	16,723	10.8	7.9	9.7	
LAKEVIEW	"	5.0	50	12	3.79	3.4	66	73	1,209.4	54,372	7.4	2.8	4.5	0.5
BRANTFORD	"	12.5	5+ OUT-FALL	5	5.75	5.59	10.9+	11.2+	2,040.3	15,241	2.2	1.3	1.5	0.5
KITCHENER	"	13.5	15	3	7.30	7.12	27.8	28.4	656.0	19,946	4.4	1.7	3.1	0.5
MARKHAM	"	0.334	52	7	0.139	0.138	125	126	28.8	1,588	7.4	4.5	5.8	

DIGESTION

INTRODUCTION

There is no sharp line of demarcation between conventional and high rate digester loadings. Detention time is undoubtedly the proper way to express loadings, since digester behavior and the character of the end products appear to be more closely related to detention time than to organic loadings. A detention time between 10 and 15 days is considered adequate with high-rate digestion systems as opposed to conventional units at 30 to 60 days detention.

The manuals of ASCE and WPCF show the Ten States Standards recommendations of 2 to 3 cubic feet of digester capacity per capita. This can be equated to 0.043 to 0.065 pounds of volatile solids per cubic foot per day, by assuming 0.3 pounds of suspended solids per capita per day, 60 percent removal in the primary tank and 72 percent volatile solids. The manual committee recommendation considers a tenth of a pound of volatile solids per cubic foot as a reasonable loading. The range of loadings from current literature extends from 0.043 to 0.38 pounds of volatile solids per cubic foot per day. High-rate digestion is recognized by most authorities as a loading in excess of 0.15 pounds of volatile solids per day per cubic foot of digestion tank capacity. Digester loadings, sometimes stated in terms of cubic feet of digester per capita, should be reported in pounds of volatile solids per cubic foot of digester capacity per day because this parameter allows for a more meaningful comparison of data from different sewage treatment plants.

Although expressions of loadings in pounds of volatile solids per cubic foot per day are not ideal, it appears to be the best available indicator to relate design to operation. For loading rates to be valid, the volume in the digestion system available for active digestion must be known. This volume is only known when the entire digestion tank is uniformly active.

In practice, a well digested sludge requires a minimum of about 8 days of detention time independent of the loading rate. The concentration of solids in the raw sludge directly affects the volume of daily sludge production and in turn the detention time in the digester. For a constant detention period in a given digester volume, an increase in loading of pounds of volatile solids per cubic foot per day necessitates a more concentrated sludge.

Sampling, Analysis and Records

Table No. 5 summarizes sampling done and records kept for 1963 digester performance at all plants. Total solids and volatile solids should be done monthly on both digester feed sludge and digested sludge. Volatile solids should be done periodically (possibly every two months) on supernatant.

All plants except Trenton, Point Edward, Stratford, Brantford and Lakeview were lacking in some or all aspects of sampling and records kept.

Sampling and analysis done at the plant and reported on weekly summaries in some cases are not recorded in monthly summary sheets or do not agree with monthly laboratory results (e.g. Kitchener).

Brampton and Markahm digested sludge quanitites were not kept. Nepean and Streetsville digested sludge quantities appear inaccurate. Stratford and Brantford discharged more digested sludge than raw sludge they received according to the quantities.

Capacity and Loading

Detention period and solids loading are the two most important parameters in evaluating digester capacity and loading. The digester volume per capita or per volume of raw sewage is a far less indicative parameter but since Ten States Standards and Design Manuals have used this basis for design, it was also determined for the plants evaulated in this report.

No distinction is made in Ten States Standards or most design manuals between design parameters for single or two-stage digestion systems. High-rate digestion has not yet been considered in the Ten States Standards or ASCE design manual.

Design Capacity (Graph No. 8)

Based on the questionable ASCE capacity design values (ft.^{3}/ capita) the following overall digestion systems were underdesigned; Brampton, Burlington Drury Lane, Richmond

Hill, Port Colborne W.S., Lakeview, North Bay, Port Arthur and Stratford. In addition, all the primary units of the two stage digestion systems except Georgetown were designed for capacities ($ft.^3$/capita) below the ASCE range.

Digestion detentions designed for or expected were not available for most of the plants.

Actual Capacity

Based on the yearly average of digested volume in cubic feet per 100 gallons of raw sewage flow which approximates the design parameter commonly used ($ft.^3$/capita) the following plants did not have sufficient overall capacity during 1963 according to ASCE Design Manual No. 8 and Ten States Standards; Owen Sound, Burlington Drury Lane, Nepean and Port Arthur. The following primary units of two stage systems did not have sufficient capacity according to the above mentioned standard; Belleville, Owen Sound, Trenton, Brampton, Port Colborne WS, Lakeview, North Bay, Brantford, Kitchener and Burlington Drury Lane.

Based on detention periods all the single stage digestion systems had sufficient capacity but of the two stage systems all plants except Georgetown, Brampton and Port Colborne WS must be operating under high rate conditions in order to have sufficient detention. The criteria of cubic feet per capita for evaluating most OWRC plants is therefore obsolete.

Design Loading

Based on the expected solids removal and the Ten States Standards design capacity the following overall digestion systems were designed for loading (lbs solids/$ft.^3$/month) in excess of the Ten States Standard range; Richmond Hill, Brampton, Port Colborne WS, Lakeview, Brantford, Kitchener, Burlington Drury Lane, Burlington Elizabeth Gardens, Port Colborne ES, Nepean and Stratford. All of the primary units of two stage systems except Georgetown were not designed to handle this Ten State Standard loading.

Actual Loading

None of the plants on an overall digester capacity basis were loaded (lbs. VS feed/ft. ^{3}/month) during 1963 in excess of Ten States Standard recommended values. However when only the primary unit of the two stage digestion systems is considered Owen Sound, Lakeview, Brantford and Kitchener were overloaded (lbs VS feet/ft. ^{3}/month) according to Ten States Standard. If high-rate digestion conditions are to be assumed, however, none of the digesters were overloaded according to the range of loadings commonly used for such units.

Gas Production

Gas production per pound of volatile solids in the feed and per pound of volatile solids reduced are the two most important parameters in assessing digester gas production. The gas produced per 100 gallon of raw sewage per day gives an indication of strength of sewage and sludge removal efficiencies but does not reveal much about the digester performance. However, Belleville and Owen Sound were below the range reported in ASCE Design Manual No. 8 for ft. ^{3} gas/ 100 gallon raw sewage/day. The remainder of the plants were within the range. Owen Sound has very poor gas production for volatile solids in feed but no information was available to determine gas production for volatile solids reduced. The large quantities of non-volatile solids reaching the digester are probably responsible for the poor performance.

Reductions (Graph No. 9)

Georgetown, Richmond Hill, Lakeview, Brantford, Fergus, and Stratford show below average solids reduction. Lack of sufficient sampling may be responsible for the indicated poor reductions of Georgetown, Richmond Hill and Fergus.

Brantford is the only plant for which an explanation is not evident for the large differences obtained when the results of the two methods of solids reduction are compared. According to the sampling at Brantford, which is sufficient, there is no reduction in total solids and only a small reduction in volatile solids. Only possible explanation is that the method of sampling the feed and/or digested sludge does not give representative samples.

SUMMARY OF 1963 DIGESTER PERFORMANCE

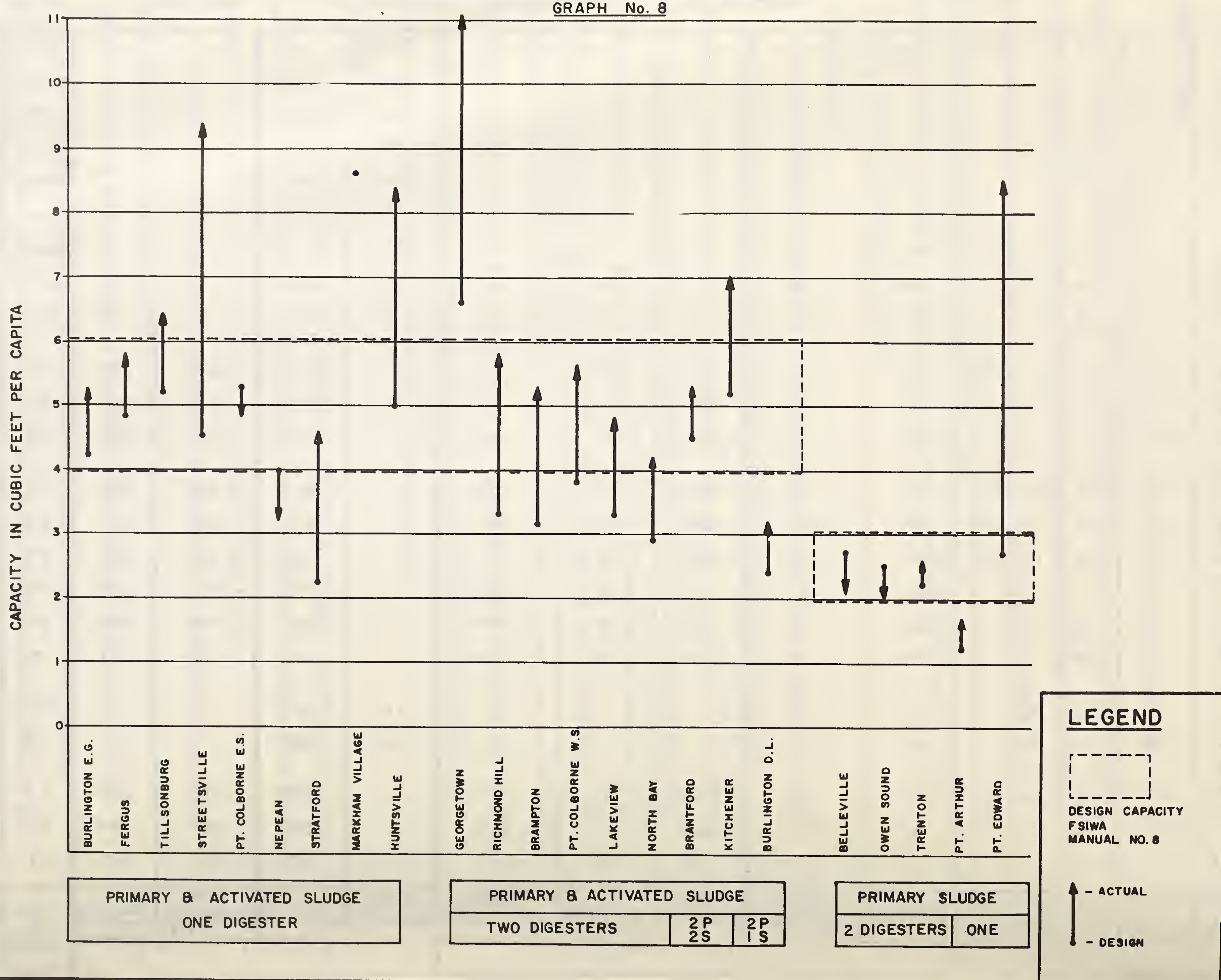
TABLE NO. 5

PROJECT	TYPE	DESIGN FLOW (MGD)	DESIGN LOADING: PRIMARY $(FT.^3/CAP)$	DESIGN LOADING: PRIMARY $(LBS.SS/FT.^3/DAY)$	DESIGN LOADING: TOTAL $(FT.^3/CAP)$	DESIGN LOADING: TOTAL $(LBS.SS/FT.^3/MO.)$	ACTUAL LOADING: PRIMARY $(FT.^3/100$ GAL. RS/DAY)	ACTUAL LOADING: PRIMARY (DET/DAYS)	ACTUAL LOADING: PRIMARY $(LB.RS/FT.^3/DAY)$	ACTUAL LOADING: TOTAL $(FT^3/100$ GAL. RS/DAY)	ACTUAL LOADING: TOTAL (DET/DAYS)	RESULTS: REDUCTION TS %	RESULTS: REDUCTION VS %	RESULTS: REDUCTION VOL. %	RESULTS: GAS PRODUCTION $FT.^3/LB.$ VS FEED	RESULTS: GAS PRODUCTION $FT.^3/LB$ VS RED
1	P2	3.0	1.32	.127	2.65	-	1.04	28	.017	2.08	57	-	-	-	18	-
2	P2	3.0	1.26	.125	2.48	-	0.99	17	.107	1.95	34	-	-	-	1.8	-
3	P2	1.0	1.13	.150	2.25	-	1.28	35	.053	2.57	70	40.8	63	86	9.7	15.7
4	P1	4.0	-	-	1.25	2.00	-	-	-	1.71	58	-	69	75	12.2	17.7
5	P1	0.57	-	-	2.66	1.13	-	-	-	8.5	160	58	69	79	-	-
6	PA2	1.5	5.2	.037	6.6	-	8.7	300	.007	11.1	380	36	-	20	-	-
7	PA2	1.6	2.44	.085	3.28	-	4.34	33	.040	5.8	44	55	39	50	-	-
8	PA2	2.0	1.67	.150	3.33	-	2.65	46	-	5.3	92	-	-	-	-	-
9	PA2	0.9	2.34	.110	3.83	-	3.4	96	.027	5.6	158	74.5	61	63	7.1	11.6
10	PA2	5.0	1.64	.153	3.28	-	2.42	23	.096	4.84	46	28.3	41	20	5.7	13.7
11	PA2	4.0	1.40	.081	2.90	-	2.07	30	.030	4.2	63	34.4	57.2	61.5	17.6	30.8
12	PA4	12.5	1.50	.205	4.5	-	1.8	22	.085	5.3	66	0	41	0	6.6	16
13	PA4	11.0	1.44	.326	5.44	-	1.8	28	.080	7.0	110	65.9	-	77	-	-
14	PZA1	2.5	1.67	.090	2.43	-	2.2	34	.041	3.2	50	43.7	72	80	11.2	15.2
15	PA1	0.75	-	-	4.2	1.6	-	-	-	5.25	52	-	-	27	-	-
16	PA1	0.60	-	-	4.8	1.4	-	-	-	5.8	210	-	24	10	19.1	80
17	PA1	0.665	-	-	5.14	1.32	-	-	-	7.5	42	73	-	74	-	-
18	PA1	0.8	-	-	4.5	1.5	-	-	-	9.4	78	-	-	-	-	-
19	PA1	0.85	-	-	5.28	1.59	-	-	-	4.87	115	-	-	65	2.2	-
20	PA1	1.5	-	-	4.0	2.02	-	-	-	3.15	122	-	-	87	-	-
21	PA1	4.0	-	-	2.25	1.85	-	-	-	4.7	98	-	46	0	6.2	13.5
22	PA1	0.334	-	-	8.8	0.67	-	-	-	-	135	-	-	-	-	-
23	PA1	0.25	-	-	5.0	1.2	-	-	-	8.4	220	74.5	-	61	-	-

1. Belleville
2. Owen Sound
3. Trenton
4. Port Arthur
5. Point Edward
6. Georgetown
7. Richmond Hill
8. Brampton
9. Port Colborne W.
10. Lakeview
11. North Bay
12. Brantford
13. Kitchener
14. Burlington DL.
15. Burlington EG.
16. Fergus
17. Tillsonburg
18. Streetsville
19. Port Colborne E.
20. Nepean
21. Stratford
22. Markham Village
23. Huntsville

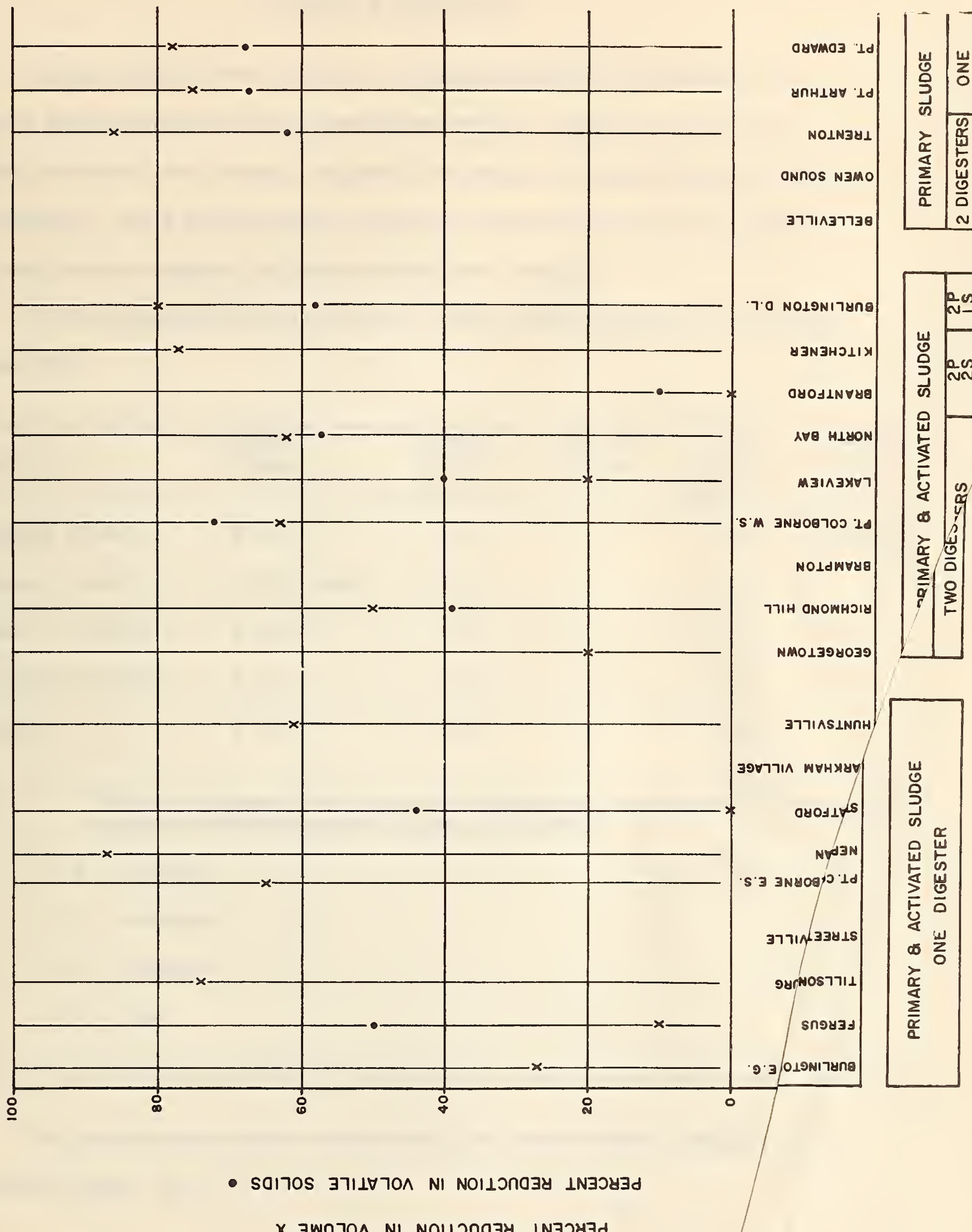
DIGESTER DESIGN CAPACITY (1963)

GRAPH No. 8



DIGESTER REDUCTIONS (1963)

GRAPH No. 9



VACUUM FILTRATION

During 1963 the OWRC operated 7 vacuum filters at 5 of its plants. The types of sludges filtered at these installations varied. Primary, primary-raw, primary-activated-raw, primary-digested and primary-activated-digested sludges were filtered. All of the filters were equipped with stainless steel coil springs for the filter media as supplied by Komline-Sanderson Limited.

The following table summarizes the vacuum filter installations in operation during 1963.

Project	Type of Sludge	Design Flow M. G.	No. of Units	Total Area Sq. Ft.	Type of Filter
Brantford 58-S-11	P-A-D	12.5	2	700	Coil Spring
Kitchener 58-S-19	P-D, P-A-D	13.5	1	500	" "
Preston 59-S-46	P-A-R	1.8	1	250	" "
S. S. Marie 59-S-20	P-R	8.0	2	400	" "
Waterloo	P-A-R	4.0	1	300	" "

NOTE: * Primary-digested sludge only was filtered until mid October at which time primary-activated-digested sludge was filtered.

P - Primary

A - Activated

D - Digested

R - Raw

The date associated with the operation of the various filter installations is recorded in Table No. 6.

CHEMICAL DOSAGES

Graph No. 10 the dosages of lime and ferric chloride as a percent by weight of the dry solids filtered are shown.

There were two installations, Preston and Waterloo, where primary activated sludges were filtered. The lime dosages at Waterloo were less than at Preston and the ferric chloride dosages were practically the same. The variation in dosages of chemicals used were considerably less at Waterloo and fell within the expected ranges as shown in the FSIWA (Federation of Sewage and Industrial Wastes Association) Manual #8. The larger variation in dosages at Preston probably were a result of inexperience with vacuum filtering at the plant as this was the first year the plant operated.

Vacuum filtering of primary-activated-digested sludges was employed at Brantford and Kitchener. The extension of the Kitchener plant to secondary treatment was not completed until the latter part of the year and therefore primary-activated-digested sludge was only filtered for a short period of time at that plant. The dosages of lime and ferric chloride used at Brantford were higher than would be expected. However, the dosages of ferric chloride after August were within the range reported in the FSIWA Manual #8. The dosages of lime to be used at this plant should be reviewed since they, were higher than normally expected. The dosages of lime at Kitchener were high but it is anticipated that these will be lower once the operation of the digesters on the mixture of primary and activated sludges is established.

The chemical dosages experienced at Kitchener with respect to the filtering of primary digested sludge were within the expected ranges.

The average dosage of chemicals at Sault Ste. Marie were within the expected ranges although there was considerable variation. This variation can be attributed to the seasonal fluctuations in raw sludge solids content which results from changes in

operation of the sludge thickening equipment (aerated tank) necessitated by the seasonal weather conditions.

YIELD

The yields experienced at the various plants are shown in Graph No. 11

Preston was the only plant able to consistently obtain yields in excess of normal design expectations. Waterloo, Kitchener (primary-digested), and Sault Ste. Marie had yields consistent with design figures. The yield at the Brantford plant was considerably below that to be expected and this in conjunction with the chemical dosages experienced indicates further review of the vacuum filter operation at this plant should be initiated. The low yield at Kitchener with respect to primary-activated-digested sludge probably reflects start-up problems.

The raw sewage entering the Preston plant contains waste from a potato chip industry. It has been observed at the plant that the sludge from this sewage dewaters quite well. This feature is reflected in the high yields reported by the plant.

OPERATING COSTS

The major operating costs involved with vacuum filtration are those for chemicals and labour. The labour costs have been arrived at by using 1 1/2 man hours for each hour of operation of the filter. Usually one man is required full-time for the operation of the unit with an extra man being required for start-up and clean-up at the end of the days filtering. The electrical costs have also been estimated. Maintenance costs are actuals but since the installations are recent, it is anticipated that these costs will increase through time.

The costs of operation the vacuum filters at the various projects are as follows:

Project	$FeCl_3$	Cost Per Dry Ton Filtered Lime	Labour	Elec.	Maint.	Total
Sault Ste. Marie	$3.44	$1.42	$2.97	$0.07	$0.03	$8.23
Kitchener	4.14	1.90	3.15	1.00	1.24	11.44
Brantford	4.79	2.75	4.31	1.40	0.60	13.97
Preston	2.66	2.14	2.64	0.72	0.09	8.25
Waterloo	3.53	2.54	3.21	0.64	0.14	10.06

The highest operating cost was that experienced at Brantford. The sludge filtered at this plant was primary-activated-digested which is considered the most difficult to coagulate and filter. The cost of $11.44 per dry ton filtered at Kitchener is high since during the latter part of the year primary and activated-digested sludge was filtered.

OWRC WATER POLLUTION CONTOL PLANTS
VACUUM FILTRATION
1963

TABLE 6

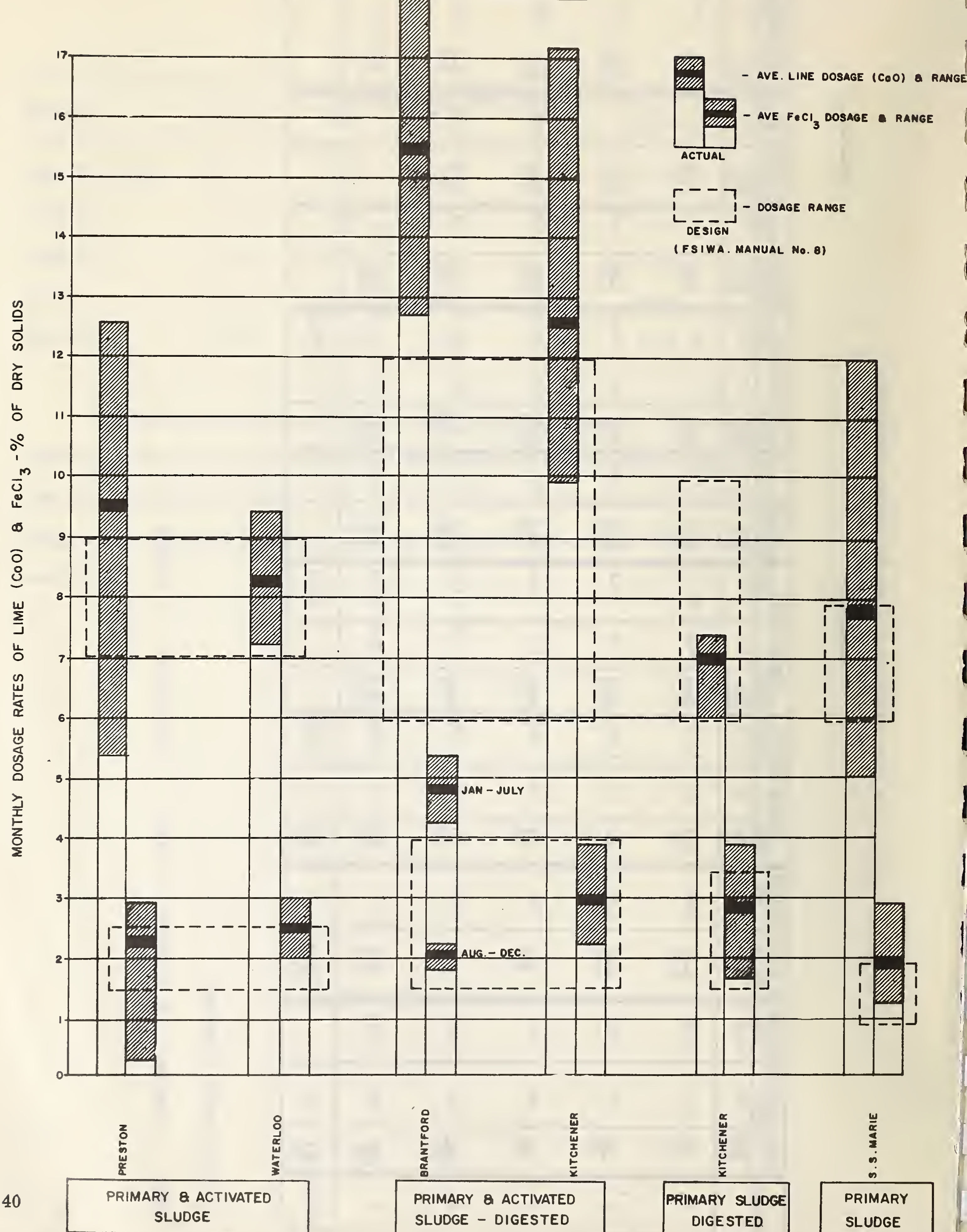
PROJECT	HRS. FILTERING/FILTER Monthly Max./Min.	HRS. FILTERING/FILTER Monthly Av.	HRS. FILTERING/FILTER Year Total	% SOLIDS IN FEED Monthly Max./Min.	% SOLIDS IN FEED Year Av.	TONS OF SOLIDS Monthly Max./Min.	TONS OF SOLIDS Monthly Av.	TONS OF SOLIDS Year Total	TONS OF LIME Monthly Max./Min.	TONS OF LIME Monthly Av.	TONS OF LIME Year Total	% LIME Monthly Max./Min.	% LIME Year Av.	TONS OF $FeCl_3$ Monthly Max./Min.	TONS OF $FeCl_3$ Monthly Av.	TONS OF $FeCl_3$ Year Total	% $FeCl_3$ Monthly Max./Min.	% $FeCl_3$ Year Av.	% SOLIDS CAKE Monthly Max./Min.	% SOLIDS CAKE Year Av.	YIELD PSF/HR. Monthly Max./Min.	YIELD PSF/HR. Year Av.
1	302/170	211	2,533	5.18/4.43	4.86	274/162	209	2,510	41.2/26.5	32.3	387.5	17.7/12.7	15.4	11.5/4.2	7.4	88.5	5.35/1.81	3.52	17.0/14.2	15.2	3.39/2.47	2.94
2*	132/20	75	897	10.9/4.67	8.80	191/21	107	1,283	14.0/2.0	7.5	95.3	16.6/6.2	7.45	6.2/.5	3.2	37.8	3.93/1.70	2.96	19.7/14.0	17.0	6.88/2.68	5.72
3	126/28	89	983	9.2/6.6	7.9	104/18	69	767	10.5/0.9	6.7	73.4	12.5/5.3	9.5	2.6/0.04	1.6	17.3	2.9/0.24	2.26	28.0/21.0	24.0	8.2/4.9	6.25
4	156/76	107	1,288	7.6/3.6	5.2	176/85	136	1,635	14.5/8.2	10.5	125.7	12.1/5.0	7.7	3.7/2.3	2.7	32.3	2.9/1.3	2.0	27.4/18.3	24.4	12.7/5.9	8.2
5	324/183	278	3,331	5.6/4.3	5.0	209/125	177	2,121	24.4/14.2	20.3	244.5	9.4/6.9	8.3	5.1/3.5	4.3	51.6	3.0/2.0	2.5			4.6/3.7	4.1
SUMMARY	324/20	152		10.9/3.6		274/21		8,316			926.4					227.5						

*PRIMARY DIGESTED SLUDGE ONLY.

NOTE: 1. BRANTFORD 2. KITCHENER 3. PRESTON 4. SAULT STE. MARIE 5. WATERLOO

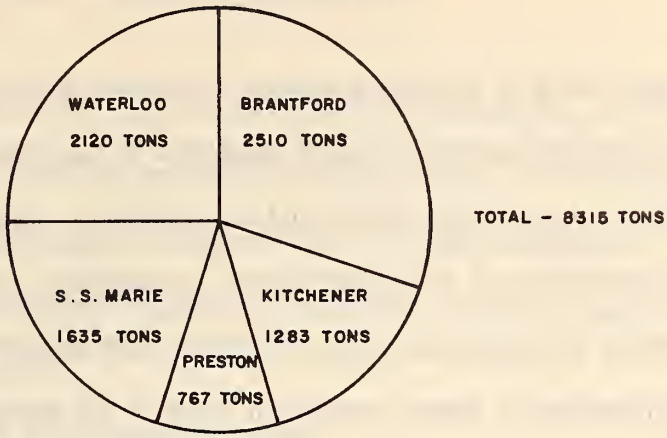
CHEMICAL DOSAGES – % DRY WEIGHT

GRAPH No. 10

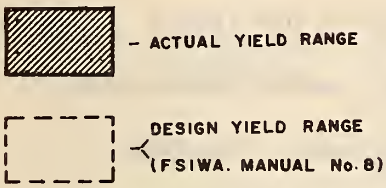


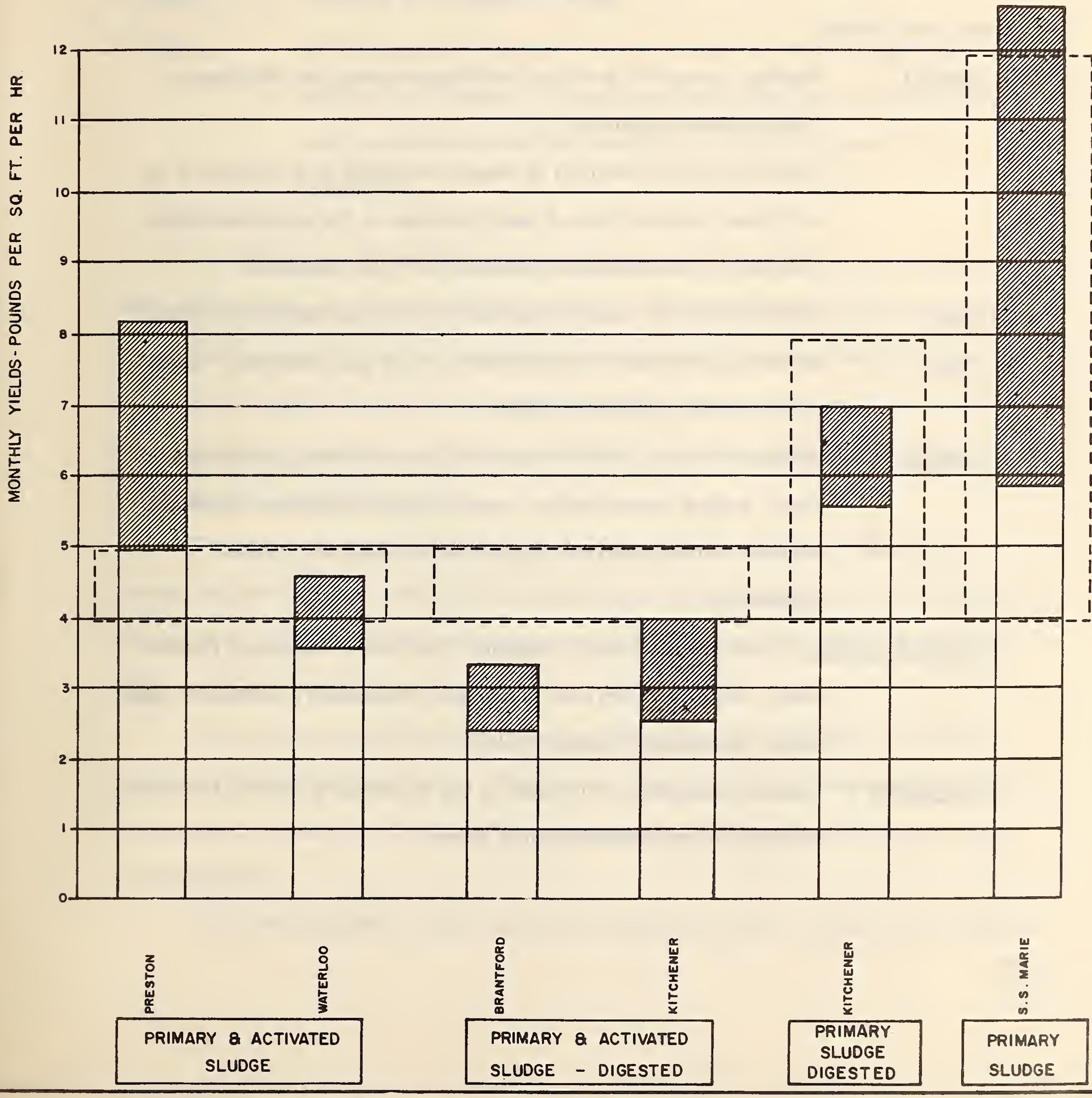
TONS OF DRY SOLIDS FILTERED (1963)

GRAPH No. 11



VACUUM FILTER YIELDS





OPERATING COSTS (See Table 7, page 46)

The total costs of operating sewage treatment plants as used in this report are those involving the payroll of staff employed at the plants, fuel, power, chemicals, general supplies, equipment, repair and maintenance, sundry and water. The cost of head office supervision, including travel, accounting, purchasing and inspection is not included in the operating costs shown for each project.

An explanation of items included in each of the categories of the operating costs is as follows:

1. Payroll - Regular operators' salaries including pension and Workmen's Compensation payments.
   - Casual payroll - Salaries of labour employed on a temporary or part-time basis in time of staff shortage or for part-time work. Workmen's Compensation payments are also included.
2. Fuel - Includes fuel oil, natural gas, and/or propane used for heating.
3. Power - Includes hydro electric power and natural gas, gasoline, diesel oil if used for power generator.
4. Chemicals - Includes chlorine, ferric chloride, hydrated lime, pickle liquor, alum, sodium hypochloride, odour control chemicals, activated carbon, sodium chloride, pipe cleaning materials (where applicable).
5. General Supplies - Includes laboratory reagents, laboratory equipment replacement, cleaning materials, lubricants, stationery, uniforms, light bulbs, instrument charts, books.
6. Equipment - Includes equipment to be used in the treatment process, laboratory, building and grounds and small tools.

7. <u>Maintenance & Repair</u> - Includes goods and services (with the exception of OWRC staff) used in repairing and maintaining process, electrical and building equipment, inspections, packing, paint, etc.

8. <u>Sundry</u> - Includes express charges, telephone, telemetering, stamps, sludge haulage, etc.

9. <u>Water</u> - Includes all charges for water.

10. <u>Travel</u> - Includes operators' travel to local hardware stores, railroad station, conferences, conventions, etc. The cost of accommodation and meals associated with conferences and conventions is also included.

The major contributor to the cost of operation of the plants was that of payroll. On the average this represented forty-five percent of the total operating cost. The payroll as a percent of the operating cost ranged from a low of thirty percent at Belleville to a high of sixty-four percent at Fergus. Other plants for which payroll represented a large portion of the total operating costs were: Port Arthur (60), Port Colborne (60), and Brantford (57).

The costs of power and sundry (including sludge haulage) were the items forming the next largest portion of the operating costs representing 14 and 17 percent respectively. The cost of the above three items represented from 62 to 90 percent of the operating costs for plants.

The cost per million gallons of sewage treated is given in Table 8 and displayed graphically in Graph No.12. Two curves, one for primary plants and the other for secondary plants have been used to represent the average cost for plants in these two categories.

The following plants varied from the average as shown in Graph No. 12 and 13.

1. Trenton - The cost per million gallons treated was less than average due to the high flows experienced at the plant. Sixty percent of the daily flows exceeded the design capacity of the plant.

2. Sault Ste. Marie - The cost of operating this plant was slightly in excess of the average cost as shown on the graph. It should be noted that the largest primary plant exluding the Sault Ste. Marie plant has a design capacity of 3.0 MGD and, therefore, the portion of the curve representing plants greater than 3 MGD is projected. This plant was substantially underloaded for most of the year and as a result the cost per million gallons of sewage treated was higher than average.

3. Waterloo - The plant was overloaded organically which resulted in a high cost of operating. Since the hydraulic capacity of the plant was seldom exceeded, the cost per million gallons treated was higher than the average as shown by the curve. The cost per pound of BOD removed was less than the average.

4. Brantford - The average flow at the plant was less than fifty percent of design and therefore, the unit costs of operation were high.

5. Westminster - This plant was the only total oxidation plant in operation during the year.

6. Owen Sound - The cost per pound of BOD removed was low as a result of high BOD removal efficiencies (65 percent average).

7. Point Edward - This plant is quite small compared to the other primary plants and therefore the unit costs of operation were high.

8 & 9 Burlington Elizabeth Gardens and Streetsville - Both of these plants receive sewage with a high BOD content. As a result the unit cost for BOD removed is low.

10. Nepean - High flows due to infiltration were experienced at this plant. This overloaded hydraulic condition resulted in low BOD removal efficiencies and a high unit cost for BOD removed.

11. Port Colborne - Low concentrations of BOD resulted in high unit costs for its removal.

12. Kitchener - The extension of this plant from primary to complete treatment was not completed until the latter part of the year. As a result the unit costs of operation are high for a secondary plant.

OPERATING COSTS - 1963

TABLE 7

* DENOTES A CREDIT

PROSPECT	TOTAL EXPENDITURE	PAYROLL	CASUAL PAYROLL	FUEL	POWER	CHEMICAL	GENERAL SUPPLIES	EQUIPMENT	REPAIRS & MAINTENANCE	SUNDRY	WATER
POINT EDWARD	11,344	4,856	-	1,269	751	993	379	443	208	2,202	243
TRENTON	12,104	4,634	410	302	2,452	1,165	812	87	299	1,103	839
BELLEVILLE	42,885	13,060	-	1,815	5,814	3,886	1,506	149	653	14,486	1,517
OWEN SOUND	25,012	11,651	1,127	1,967	4,388	2,809	1,256	115	137	713	850
PORT ARTHUR	32,701	17,538	2,169	593	4,482	2,261	1,297	183	1,241	2,077	860
SAULT STE. MARIE	107,538	47,201	72	2,643	13,772	13,336	2,333	2,206	4,380	20,185	1,409
HUNTSVILLE	9,646	3,836	373	492	1,140	326	523	-	622	1,945	389
FERGUS	12,731	8,129	-	608	1,085	669	808	2	573	732	136
TILLSONBURG	19,753	8,268	-	485	4,444	582	800	309	1,445	3,214	208
BURLINGTON EG	26,010	9,419	-	1,061	3,994	2,168	893	227	1,943	5,951	480
STREETSVILLE	14,298	4,220	2,633	739	1,727	664	1,687	46	943	1,407	231
MARKHAM	16,771	8,591	-	970	1,832	189	668	190	2,140	1,968	222
PORT COLBORNE	60,755	36,606	-	1,939	7,806	1,646	3,096	2,928	1,985	4,193	556
ORANGEVILLE	13,348	4,481	-	285	1,292	1,983	332	576	285	4,114	-
GEORGETOWN	26,695	11,918	-	1,503	3,813	1,343	1,387	434	2,051	3,628	498
NEPEAN	31,926	12,264	2,120	2,467	7,423	251 *	902	494	2,910	2,022	1,573
RICHMOND HILL	42,954	18,315	3,798	1,618	4,817	2,636	1,047	105	2,270	8,347	-
PRESTON	30,651	11,953	1,015	263	2,789	8,417	1,192	478	366	2,677	1,240
BRAMPTON	29,054	11,147	1,441	475	5,195	3,212	794	427	2,201	3,496	667
BURLINGTON DL	43,454	23,862	-	6	7,419	3,277	1,138	378	1,497	5,007	137
STRATFORD	52,800	24,952	3,786	274	5,380	367	3,135	690	5,025	8,535	620
NORTH BAY	67,131	29,968	1,210	411	8,564	20	2,422	391	2,446	16,909	4,789
WATERLOO	96,410	32,173	1,594	1,896	19,252	22,163	2,548	36	3,305	13,424	-
LAKEVIEW	118,027	31,832	2,163	552	11,494	4,573	2,599	789	2,679	60,751	593
BRANTFORD	175,173	99,735	849	2,226	24,939	27,025	3,571	758	2,200	9,782	4,089
KITCHENER	137,547	69,518	3,936	677	17,341	17,918	5,115	1,649	7,368	16,850	175
WESTMINSTER	8,503	4,172	328	37	2,249	43 *	298	-	209	1,252	-
TOTAL	1,265,221	564,299	29,024	27,573	175,654	123,334	42,538	14,090	51,381	216,970	22,321
% OF TOTAL	100	45	2	2	14	10	3	1	4	17	2

* denoted as credit

TABLE 8

OPERATING COSTS/MILLION GALLONS, /LB. BOD REMOVED, AND/ CAPITA

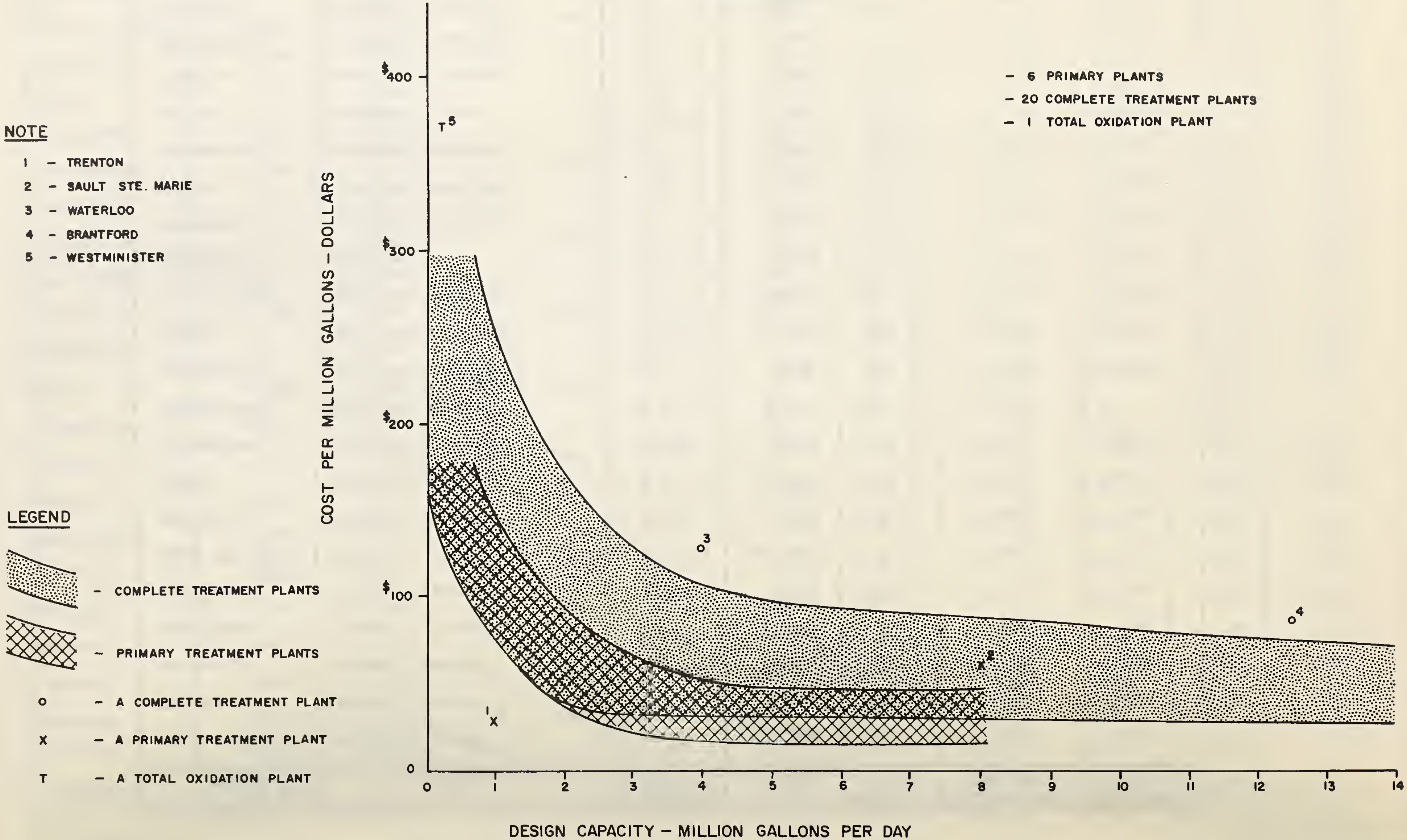
1963

PROJECT	TYPE	DESIGN CAP. MGD.	OP. COSTS	COST/MG. $	COST/LB. BOD REM. ¢	COST/CAPITA $
Point Edward	Primary, Digester	0.57	11,344	175	22.0	4.10
Trenton	Primary, Digester	1.0	12,104	32	5.5	0.92
Belleville	Primary, Digester	3.0	42,885	31	5.9	1.40
Owen Sound	Primary, Digester	3.0	25,012	22	2.3	1.40
Port Arthur	Primary, Digester	4.0	32,701	35	3.5	0.74
Sault Ste. Marie	Primary, Filter	8.0	107,538	61	9.6	1.73
Huntsville	Secondary, Digester	0.25	9,646	148	12.0	3.22
Fergus	Secondary, Digester	0.6	12,731	89	5.3	3.22
Tillsonburg	Secondary, Digester	0.665	19,753	114	5.1	2.99
Burlington EG	Secondary, Digester	0.75	26,010	121	3.3	
Streetsville	Secondary, Digester	0.8	14,298	102	2.3	2.68
Markham	Secondary, Digester	0.334	16,771	278	11.0	3.18
Port Colborne	Secondary, Digester	1.75	60,755	181	16.0	4.03
Orangeville	Secondary	0.75	13,348	83	6.7	2.70
Georgetown	Secondary, Digester	1.5	26,695	82	9.3	2.49
Nepean	Secondary, Digester	1.5	31,926	47	11.7	3.19
Richmond Hill	Secondary, Digester	1.6	42,954	130	6.2	2.32
Preston	Secondary, Filter	1.8	30,651	108	2.4	2.00
Brampton	Secondary, Digester	2.0	29,054	54	2.2	1.31
Burlington DL	Secondary, Digester	2.5	43,454	52	3.0	1.45
Stratford	Secondary, Digester	4.0	52,800	68	3.5	2.53
North Bay	Secondary, Digester	4.0	67,131	54	3.6	1.70
Waterloo	Secondary, Filter	4.0	96,410	127	2.0	4.07
Lakeview	Secondary, Digester	5.0	118,027	98	5.0	
Brantford	Secondary, Digester, Filter	12.5	175,173	86	7.0	3.17
Kitchener	Secondary, Digester, Filter	13.5	137,547	49	4.7	1.75
Westminster	Total Oxidation	0.25	8,503	376	22.0	1.39

1963 OPERATING COSTS

COST PER MILLION GALLONS VS. DESIGN CAPACITY

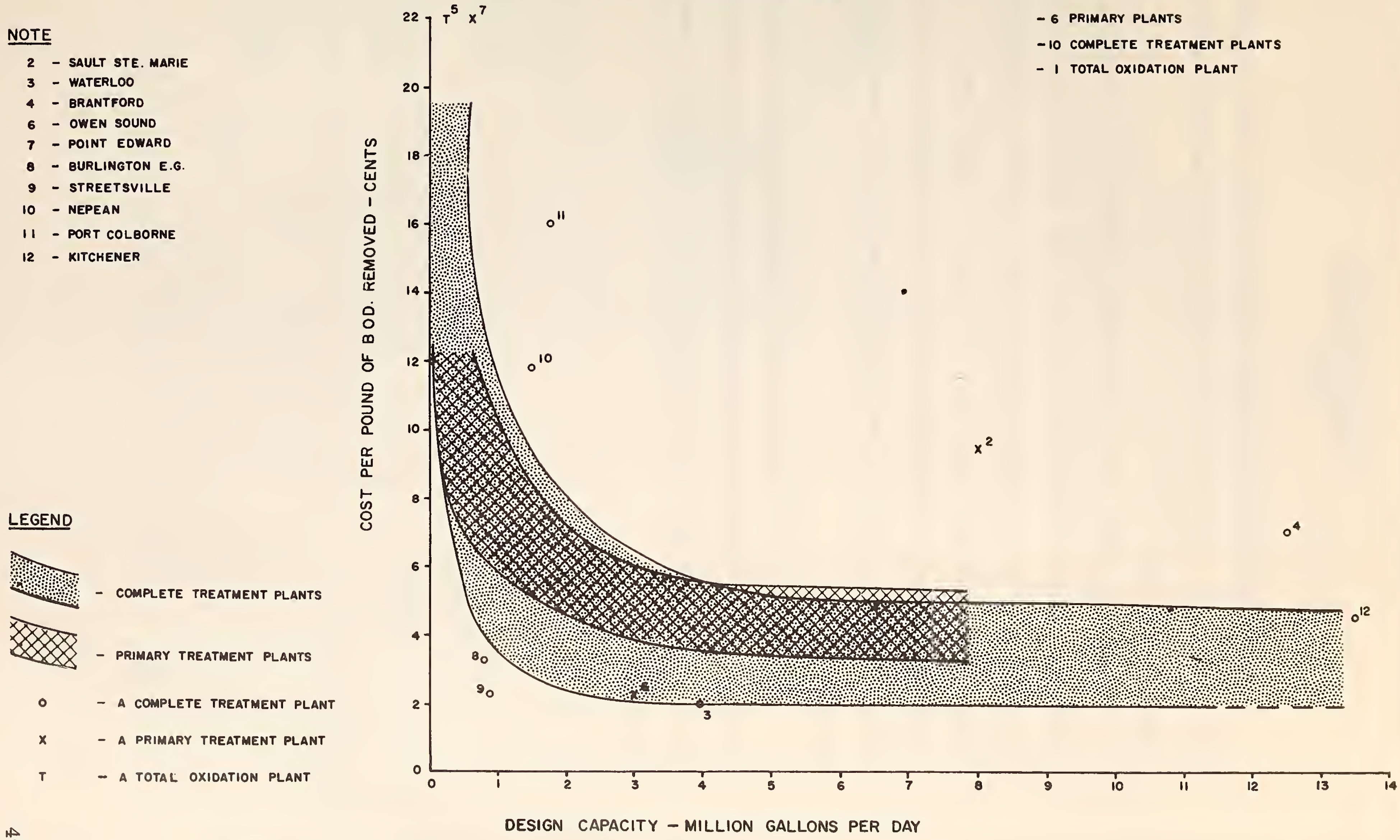
GRAPH No. 12



1963 OPERATING COSTS

COST PER POUND OF BOD. REMOVED VS. DESIGN FLOW

GRAPH No. 13



OPERATING STAFF

Five of the twenty-seven plants in operation during 1963 were staffed with one man only. The largest staff consists of twenty-one men, was employed at the Brantford plant.

Most of the primary plants with design capacities of one MGD or more employed one man for each one MGD of design. The secondary plants employed approximately 2 men for each one MGD of design. Exception to this were Port Colborne (0.22 MGD per man), where two separate treatment plants and a number of pumping stations are maintained by the plant staff, Richmond Hill (0.32 MGD per man) and Kitchener (0.71 MGD per man) which was a primary plant for most of the year.

A summary of the staffing at each of the plants is shown in Table No. 9. The number of staff in each job classification at the plant is also recorded. Where staff has been employed for part of a year it is shown as a decimal fraction of a man-year.

OPERATING STAFF

1963 TABLE NO. 9

Project	Type	Des. Cap. mgd.	CLASSIFICATION: Superintendent	Asst. Supt.	Chief Operator	Foreman	Plant Mechanic	Plant Elect.	Lab. Tech.	Filter Op.	Senior Op.	Operator	Grounds Janit.	Clerk	Casual	Total	MGD per man
Point Edward	Primary Digester	0.57			1											1	0.57
Trenton	"	1.0			1										0.1	1.1	0.9
Belleville	"	3.0			1							2				3	1.0
Owen Sound	"	3.0			1							2			0.3	3.3	0.9
Port Arthur	"	4.0			1							3			0.6	4.6	0.9
S.S. Marie	Primary Filter	8.0	1				1			1		6	1			10	0.8
Huntsville	Secondary Digester	0.25			1											1	0.25
Fergus	"	0.6			1							1				2	0.3
Tillsonburg	"	0.665			1							1				2	0.33
Burlington E. G.	"	0.75			1							1				2	0.38
Streetsville	"	0.8			1										1	2	0.4
Markham	"	0.334			1							1				2	0.17
Port Colborne	"	1.75			1		1					6				8	0.22
Orangeville	"	0.75			1											1	0.75
Georgetown	"	1.5			1							2				3	0.5
Nepean	"	1.5			1							2			0.5	3.5	0.4
Richmond Hill	"	1.6			1							3			1	5	0.32
Preston	Secondary Filter	1.8			1							2			0.3	3.3	0.55
Brampton	Secondary Digester	2.0			1							2			0.3	3.3	0.6
Burlington D. L.	"	2.5	1									4				5	0.5
Stratford	"	4.0	1									5			1	7	0.58
North Bay	"	4.0	1				1	1				4			0.3	7.3	0.55
Waterloo	Secondary Filter	4.0	1									6			0.4	7.4	0.54
Lakeview	"	5.0	1				1					4	1		0.6	7.6	0.66
Brantford	Secondary D & F	12.5	1	1		5	1		1	1		9	1	1	0.25	21.25	0.59
Kitchener	"	13.5	1	1		1	1	1	1		5	5	2		1	19	0.71
Westminster	Total Oxidation	0.25			1										.1	1.1	0.23
TOTAL			8	2	19	6	6	2	2	2	5	71	5	1	6.75	136	

SUMMARY

Most of the water pollution control plants operated by the Division of Plant Operations during 1963 were in operation for less than three years. As a result, when units of one plant are compared with those of others, some of the inconsistencies which appear will be a reflection on the immaturity of operating experience at that plant. Other reasons for inconsistency may include sampling errors, overloading, underloading and additional unusual operating conditions.

The report involved a review of several areas of operation associated with the water pollution control plants operated by the Division. A summary of the results of the review for each of these areas is given below:

Grit Removal - The volume of grit at the plants studied varied from a fraction of a cubic foot per million gallons to over thirteen. The majority of plants had grit removals in the neighbourhood of 2 to 3 cubic feet per million gallons.

Loading - The Belleville, Trenton and Township of Nepean plants experienced flows in excess of their respective designs more than half the time. Owen Sound also experienced hydraulic overload. The plants at Waterloo, Belleville, Trenton and Burlington (E. G.), were overloaded with respect to BOD and for suspended solids.

Aeration Tank Peformance - Several plants used excessive amounts of air for each pound of BOD removed. This resulted from lack of aeration flexibility, maintaining a high mixed liquor suspended solids to control foam or the use of Sparjers as the diffusion device.

Chlorination - Excessive amounts of chlorine were used at the Point Edward plant as a result of its small size and lack of continuous supervision and at the Waterloo plant due to the poor quality of effluent.

Digestion - Most of the plants lacked adequate records associated with digester performance and at some plants such as Stratford and Brantford there was not a material balance. The sampling program for digesters requires review.

Vacuum Filtering - The cost of vacuum filtering at OWRC plants varied from \$8.23 to \$13.97 per dry ton of solids, with primary sludge being the least costly and primary and activated-digested sludge being the most costly. The Brantford operation displayed high chemical dosages and low yields.

Operating Costs - The unit costs of operation at the Brantford plant were in excess of those for other plants of a similar size. The cost of operation for the Waterloo plant when related to flow was very high but well within the range with respect to the BOD removed. This reflected the very high organic overload experienced at the plant.

Staffing - In general OWRC plants were staffed with one man per million gallons of plant capacity for primary plants and two men per million gallons for secondary treatment plants.